













# INCUBATORS AND CHICKEN REARERS

HOW TO MAKE AND MANAGE THEM

WRITTEN BY EXPERTS

WITH 124 ILLUSTRATIONS

CASSELL AND COMPANY, LTD  
London, New York, Toronto and Melbourne

*First published February 1913*  
*Reprinted September 1913, May 1914, May 1916, April 1917, March 1918,*  
*September 1919, March 1920.*

## PUBLISHERS' NOTE

THIS handbook replaces and supersedes a pamphlet entitled "Incubators and Chicken Rearing Appliances," which, since its first publication upwards of fourteen years ago, has sold in enormous numbers, and has been used as a practical guide to incubator matters the wide world over. The information in that pamphlet, with the exception of a few pages here included, has naturally become out of date, and the present book is published in response to a demand for a cheap but essentially up-to-date and reliable work.

Much of the matter in this handbook consists of contributions by "Leghorn," Wm. Paull, Lionel Hall, and other experts, to "Work," the Illustrated Weekly Journal of Handicrafts. The Editor of that Journal will be glad to answer any questions connected with this book which may be sent to him by interested readers.



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# INCUBATORS AND CHICKEN REARERS

## CHAPTER I

### **Principles of Incubation, Natural and Artificial**

AN incubator is an appliance for artificially incubating eggs. The verb "to incubate" suggests lying upon or sitting upon, this being the means by which a broody hen keeps her eggs warm, the heat of her body, some degrees higher than normal, being transmitted to the eggs. In an incubator, the egg-chamber is kept warm by the heat transmitted to it by hot water or hot air, depending upon the type of appliance employed. Eggs have been successfully hatched out in a very primitive arrangement, consisting of little more than a box warmed by an oil lamp, but as uniform success in artificial incubation depends essentially on close imitation of natural conditions, it follows that a reliable incubator must possess the means of ensuring an equable temperature comparable with that of the broody hen's body, and for this purpose it must be provided with a reliable heater giving a uniform flame, with means of circulating the heat, with a thermometer and with a heat regulator;

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The advantages of the artificial method of incubation over the old practice of setting eggs under broody hens are so obvious as to have nearly overcome all prejudices. The broody hen is undoubtedly preferable where only a few chickens are reared, but where hatching is on a large scale, or chickens are wanted at seasons when broody hens are scarce, it is absolutely essential to use an incubator.

To operate an incubator successfully, some knowledge is necessary of the nature of the egg, and the changes which it undergoes during the process of incubation. Roughly speaking, an egg consists of four distinct parts, namely, the shell, the membranes just inside the shell, the albumen or white, and the yellow yolk. The shell is porous, and allows of the evaporation of the moisture of the egg. At the large end of the egg is a small air-cell, which, at first not larger than a sixpence, increases as the moisture in the egg evaporates, until at the time of hatching it occupies nearly one-fourth of the interior. On the upper surface of the yolk is the germ-spot, a tiny disk about  $\frac{1}{8}$  in. in diameter, containing, if the egg be fertile, a tiny living germ. The yolk floats freely in the white, and in such a way that the germ-spot is always uppermost. The germ is the chick in embryo, and upon its proper development the whole success of incubation depends. It is extremely delicate, hence the necessity for great care in handling and storing the eggs. In winter the eggs should be collected several times a day, to prevent them getting

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chilled. Temperatures below 40° F. are usually fatal to the germ, while too much heat is also dangerous. Avoid jarring or shaking the eggs, and store them in bran in a place where the temperature keeps as nearly as possible at 60° F.

For artificial incubation, do not use eggs more than four or five days old. A hen will hatch eggs three weeks old; but an incubator does not invariably give good results with eggs more than a few days old.

There are two types of incubators in general use—hot-water (hydro) and hot-air incubators.

The hot-water incubator has a tank of hot water (heated by a lamp on the circulating-boiler principle), which radiates its heat downwards into the egg chamber. Ventilation is provided for by holes in the bottom and sides of the incubator; and moisture is produced by a tray of water underneath the egg tray, which is usually of perforated zinc.

Hot-air incubators have no water tank, and applied moisture is seldom used. There are two varieties of hot-air incubators: one has a hot-air tank, while the other has no tank at all, the outside air being heated by a lamp as it passes into the incubator, and slowly radiated through the egg chamber by means of porous diaphragms;

### **The Structure of the Egg**

The following information on the structure of the egg and the diagrams (Figs. 1 to 4) are taken, by permission;

from an American work by Charles A. Cyphers. Fig. 1 shows in diagrammatic section the various parts of a fowl's egg, in which A is the blastoderm, or germ-spot, which in a fertile egg has an outer white rim, a circular transparent area within, and inside this again an opacity, whereas in an unfertile egg no such distinct divisions can be seen; B, the white yolk, consisting of a central flask-

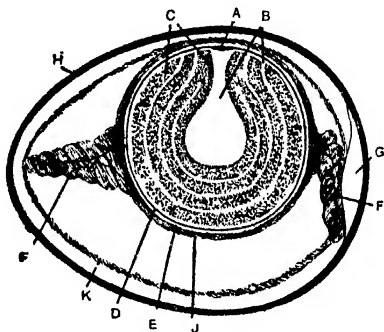


Fig. 1. —Section of Fowl's Egg

shaped mass and a number of layers concentrically arranged around it, the outer layer of white yolk lying immediately beneath the vitelline, or yolk membrane, and connected with the central mass beneath the blastoderm; c, the yellow yolk; d, the vitelline or yolk membrane; e, a layer of more fluid albumen surrounding the yolk; f, the chalaze, two twisted cords of albumen, which keep the yolk more steady in the albumen, and moderate the effects of shock; g, the air chamber between the two layers of

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the shell membrane; H, the shell, consisting of inner and outer porous layers, on the inner side of the former being a thicker outer membrane and a thin inner one which tend to separate at the broad end of the egg and form a space, G, in which air accumulates; J, denser albumen (the "white" of the egg), which extends around the yolk outside the internal layer of more fluid albumen; K, the

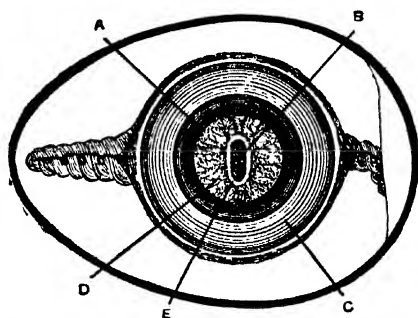


Fig. 2.—Section of Egg after 48 hours' Incubation

boundary between the outer and middle portions of the albumen:

During the descent of the egg along the oviduct of the fowl, where it is exposed to a temperature of 110° F. or more, the germ-spot undergoes changes which are arrested when the egg is cold, only to be renewed under the influence of the higher temperature of incubation. Owing to the lower density of that part of the yolk immediately surrounding it, the germ-spot is always found uppermost, provided

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the yolk is free to rotate. The yolk, too, is lighter than the albumen in which it is immersed, but the pressure of the germ-spot against the shell is moderated by the weight of the chalaze F (Fig. 1).

### The Development of the Embryo

A fowl's egg, after about 48 hours' incubation, is shown in Fig. 2, the view being from above, and not a vertical section as in Fig. 1. The germ-spot, which at first lies with its margin on the circular wall of the flask-shaped white yolk (see Fig. 1), spreads out, when incubation begins, and forms a thin circular sheet over the yolk, ultimately, and at a late period, completely enveloping it. In Fig. 2, A indicates the area opaca, the portion of the germ-spot which extends as above described; D, the vascular part (from which form the blood-vessels) of the area opaca, and E, the area pellucida; both D and E grow, but not so fast as A. The embryo B is in the centre of the area pellucida, C is the yolk.

During the first twelve hours of incubation the germ-spot, when viewed from above, is found to increase greatly in size. The central white spot, or pellucid area, becomes oval in outline and distinct. During the latter part of the first day is seen the first definite appearance of the head. At the beginning of the second day the head alone projects above the rest of the germ, the remainder of the embryo being simply a part of a flat germ-spot. At about the

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twenty-sixth hour the tail makes its appearance, being raised above the level of the germ-spot in the way that the head was raised. The first rudiment of the head appears about the twenty-seventh hour, and is of a tubular character, being formed by a longitudinal fold of the vascular layer. For some time it is undivided, being simply a long tube extending through nearly the whole

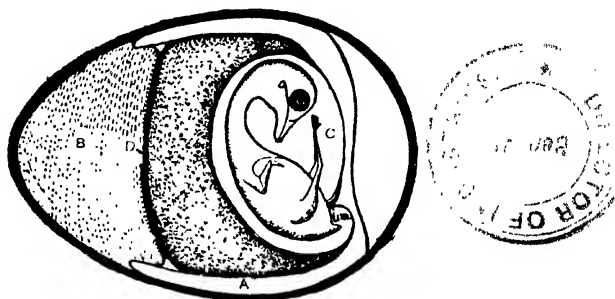


Fig. 3.—Section of Egg after 11 days' Incubation

length of the embryo. Although the development has proceeded thus far at about the thirty-fifth hour, no motion is seen in the heart or vessels until the thirty-eighth or fortieth hour.

Between the fortieth and fiftieth hours a separation of the heart in parts may be observed, and between the fiftieth and sixtieth hours the circulation of blood in the vascular area becomes more vigorous. The blood-vessels become connected during the latter part of the second day, so as to form a complete system through which the



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blood definitely circulates. By the end of the third day the area opaca of the germ-spot is spread over about half the yolk ; the vascular area is much smaller than the area opaca, and still smaller is the area pellucida, in the centre of which is the rapidly growing embryo. During the third day a remarkable change takes place in the position of the embryo. Up to this time it has been lying symmetrically upon the yolk with the part which will be its mouth directed downwards. (If an egg be placed with its broad end to the right of the observer, the head of the embryo will in nearly all cases be found pointing away from him. Out of 166 examined, Duval found 163 in this position.) It now turns round so as to lie on its left side. This change of position is almost invariably completed on the third day. Coincidentally with the change of position the whole embryo begins to curve on itself ; this curvature of the body becomes still more marked on the fourth day.

At the middle or end of the fourth day, the embryo is found to have greatly increased its size, and to be lying in almost immediate contact with the shell membrane. The blood is circulating more actively. The tail, first noticeable on the third day, has become a conspicuous feature of the embryo, which has become more curved upon itself. The distinct appearance of the limbs must be reckoned as one of the most important events of the fourth day. The allantois (an appendage of the alimentary canal)

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becomes conspicuous for the first time on this day, though its rudiments appear on the third ; it may be recognised as a pear-shaped vesicle, connected with the under surface of the alimentary (feeding and nourishing) canal by a long hollow stalk. It does not, during the third day, project beyond the body of the chick, but on the fourth it begins to pass out on its way to that space between the external

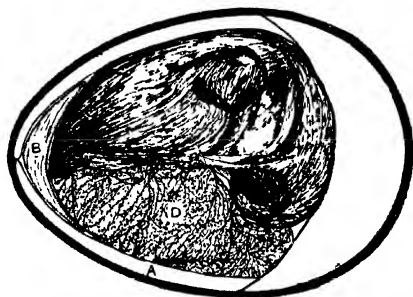


Fig. 4.— Section of Egg after 16 days' Incubation

and internal folds of the amnion. In this space it spreads out and eventually encloses the whole contents of the egg beneath the shell membrane A (Fig. 4). On the first half of the day it is very small, and its growth is not very rapid ; in the latter half of the day its growth becomes more rapid. There are no new features to record on the fifth day ; the embryo remains excessively curved—so much so, indeed, that the head and tail are nearly in contact. The amnion at its complete closure on the fourth day very closely invested the body of the chick ; the true

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cavity of the amnion was then, therefore, very small. On the fifth day fluid begins to collect in the cavity, and raises the membrane of the amnion to some distance from the embryo. The cavity becomes still larger by the sixth day, and on the seventh day it is of very considerable dimensions, the fluid increasing in it.

By the sixth or seventh day the flexure of the body has become less marked, so that the head does not lie so near to the tail as on the previous days, and at the same time a more distinct neck makes its appearance. Though the head is still disproportionately large, its growth now ceases to be greater than that of the body. By the seventh day very obvious movements begin to appear in the amnion; its slow vermicular contractions creep rhythmically over it. The amnion, in fact, begins to pulsate slowly and rhythmically, and by its pulsation the embryo is rocked to and fro in the egg. The allantois has grown rapidly and now forms a flattened bag, filled with fluid, covering the right side of the embryo. The yolk is not so fluid as on the sixth day, though it continues to absorb the white of the egg, which is diminishing rapidly. During the eighth, ninth, and tenth days the amnion does not undergo any very important changes. Ossification (the changing of the flesh into bone) begins on the eighth or ninth day. On the eighth day a chalky-looking patch is observable on the top of the nose. This, by the twelfth day, will be developed into horny but still soft beak.

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On the thirteenth day nails will be visible at the extremities, and scales on the remaining portions of the toes. These on the sixteenth day will become harder and more horny, as does also the beak. By the thirteenth day the cartilaginous skeleton will be completed, and the various muscles of the body can now be discerned with tolerable clearness.

As early as the ninth or tenth day the sacs containing the feathers begin to protrude from the surface of the back as papillae, especially prominent at first along the middle line of the back, from the neck to the rump and over the thighs, the sacs of the tail feathers being very conspicuous. On the thirteenth day these sacs, being generally distributed over the body, and acquiring a length of  $\frac{1}{4}$  in. or more, appear to the naked eye as feathers, the thin walls of the sacs allowing their contents, now coloured according to the breed of the bird, to shine through. They are still, however, closed sacs, and, indeed, remain such even on the nineteenth day, when many of them are of considerable length.

Fig. 3 shows the egg after eleven days' incubation. A is the cavity of the allantois; B, the albumen; C, the cavity of the amnion; D, the umbilicus, or small hollow tube connecting the embryo with the amnion, yolk-sac, and allantois.

By the eleventh day the abdominal walls, though still softer and less formed than the walls of the chest, may

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be said to be definitely established, and the loops of intestine, which have hitherto been hanging down, are drawn up into the abdomen. The body of the embryo is therefore completed, but it still remains connected with its various appendages with a narrow umbilicus (Fig. 3), in which run the stock of the allantois and the solid cord suspending the yolk-sac. The allantois, still growing rapidly, completely surrounds the whole contents of the egg, except at the pole opposite to the embryo, where for some little time a small portion of albumen remains unenclosed; at this spot the diminished white of the egg adheres as a dense viscid plug.

As early as the sixth day movements may be seen in the limbs of the embryo upon opening the egg. They cannot, however, be of any great extent until the fourteenth day, for up to this time the embryo retains the position in which it is formed—namely, that with its body at right angles to the long axis of the egg. On the fourteenth day a definite change of position takes place; the chick moves so as to lie lengthwise in the egg, with its head opposite the chorion and shell membrane, where they form the inner wall of the rapidly increasing air-chamber at the broad end. By the eighteenth day the fluid in the amniotic sac, in which the embryo lies, has entirely disappeared, and the chick is breathing the air which it contains. The pulmonary circulation, which has been gradually developing since the third day, increases in

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activity, and the circulation of blood in the allantois correspondingly diminishes.

The fowl's egg sixteen days incubated is shown by Fig. 4. A is the cavity of the allantois. The allantois now completely envelops the embryo and yolk-sacs, and the remaining portion of albumen, B. The amnion is losing fluid, and very closely envelops the embryo, while the yolk is seen folded over it. The allantois becomes thinner and thinner as incubation progresses, so that at the last its two walls lie in direct contact, the fluid and cavity entirely disappearing. On the nineteenth day the yolk-sac, diminished greatly in bulk, is withdrawn through the umbilicus into the abdominal cavity, which it largely distends. Outside the embryo there remains nothing now but the highly vascular allantois and the practically fluidless amnion.

By the twentieth day the fluid in the allantois has entirely disappeared, and the chick now thrusts its beak through its coverings and breathes the outer air. In from six to ten hours from the time of first breathing the outer air, the chick, breaking the shell around the broad end of the egg with rapid blows of its beak, casts off the dry remains of the amnion and allantois, and quits the shell.

### Essentials in Artificial Incubation

Only by close study of the instinctive actions of the sitting hen can the essential conditions of artificial incu-

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bation be understood and obtained. There is quite a number of special points which must be borne in mind by both the maker and user of an incubator.

The hen, in a state of nature, forms her nest on the ground in a secluded spot—frequently under a hedge. The heat of her body draws moisture from the ground and thus renders the air around the eggs more or less humid. Probably, also, in her daily perambulation in search of food, the breast feathers become wetted with the dew upon the grass, and this also adds moisture to the surfaces of the eggs, which during the hen's absence have become cooled and received an airing. Before settling down to sitting again, the hen often shuffles the eggs about with her beak, as if to make her hard bed more comfortable.

It is but fair to say that there is controversy as to the exact means by which the moisture is supplied to eggs in course of natural incubation. Hens are known to make nests in old carts, etc., under sheds, and, of course, thousands of wild birds build their nests high up in trees, so that the possibility of moisture being derived from the earth is out of the question. Many experts believe that the whole of the moisture comes to the eggs from above—from the hen's breast feathers chiefly—and they construct their incubators accordingly.

From the facts already stated, it is possible to arrive at certain conclusions as to essential conditions to be

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provided. The natural heat of a hen's body, in health, is about 98° F. (blood heat); but when the brooding instinct, rightly termed a fever, affects her, the natural heat is increased, and is given by different authorities as ranging between 100° and 106° F.

The heating of the incubator, then, should be arranged so that the temperature neither exceeds 106° nor falls below 98°. The happy mean is between these points, and probably the safest heat at which to work will be 104° F., this allowing for a slight increase without much danger of fatal results following, provided the excess is not long continued. Special attention is here drawn to the fact that the germ will stand a prolonged *lowering* of temperature much better than an increase. If the increase of heat is severe or long extended, it will generally prove fatal; a decrease of heat, under like conditions, tends but to delay somewhat the time of hatching. In whatever position the egg may be lying, this life germ always floats at the top, where it receives the greatest amount of heat. It is, therefore, of the highest importance that perfect accuracy of temperature be secured and maintained; and to this end a reliable thermometer is a prime necessity. It should be specially made for incubator work, with the scale engraved indelibly on the stem. It must be fixed in the incubator, so that the upper surface of the bulb is level with, or but slightly below, the tops of the eggs. A little time spent in arranging this to a nicety will not be wasted,



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Ventilation and moisture will be considered together, as the one depends somewhat upon the other. The shell of an egg is porous, and the natural inference is that it is so for the admission of air to the growing chick; but, as the lungs are not developed until a somewhat advanced stage of incubation, a large supply cannot be required during the previous period. Presumably, also, it is porous for the admission of a certain amount of moisture. In this connection it may be noted that barometrical changes are probably a much more important factor in success or failure than is generally imagined. It certainly stands to reason that, with a low barometer, when the atmosphere is charged with abundant moisture, there is not much danger of the supply inside the incubator being insufficient, and probably an excessive supply may be harmful to the well-being of the embryo chick. On the other hand, when the barometer ranges high, and the air is dry, it is well-nigh impossible to overdo the artificial supply of moisture.

The heat supply should be arranged so that as little work as possible is thrown upon the regulator; the chief purpose of an incubator regulator is to compensate for the variable temperature of the atmosphere, and all rough adjustments should be made by regulating the size of the lamp flame. Care should be taken that the necessary moisture is maintained; that the eggs receive daily a cooling and an airing, such as they would get under natural conditions: and that they are turned so as to prevent

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the germ, which always floats at the top of the egg, from becoming fixed, thereby hindering or entirely arresting development. The egg is to be turned at least once a day, so that the germ occupies a different position in the shell. Shifting the eggs also tends to compensate for any slight inequalities of temperature which may exist in different parts of the egg chamber, by ensuring that each egg shall in turn occupy each and every part. A daily exposure of the eggs to the atmosphere (but out of a draught) for a period of from ten minutes in cold weather to twenty minutes in the warmest weather will suffice for airing.

An incubator should be worked in a room where it will not be subjected to draughts or to sudden or great changes of temperature. Do not allow loud noises in its neighbourhood; do not handle the eggs roughly or frequently; and do not open the incubator more than is absolutely necessary, especially near hatching time. Keep the lamp well supplied with good oil, and trim the wick at least every twenty-four hours; and an hour after relighting make any necessary adjustment of flame.

An important matter is the selection of the eggs to be used in an incubator. It often happens with some breeds or strains of birds, in consequence of the natural tendency to "throw back" in the progeny, or to revert to an inferior type if totally fresh blood is introduced, that continued close and in-breeding is resorted to; as a consequence, the germs are weakened, and though under hens

## INCUBATORS AND CHICKEN REARERS

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the eggs may develop into living birds, in incubators they may prove failures. But the crossing of specimens of two distinct breeds, whilst it may cause a reversion to an inferior type for exhibition purposes only, will wonderfully increase the vitality of the germ and resultant chick.

The eggs most suitable for artificial incubation, therefore, are those from first crosses—where the parents on either side are pure bred; but when a fair measure of success is attained with these, attempts may be made with eggs from highly-bred pure breeds with greater chances of success. To procure from shops “new-laid” eggs of doubtful freshness, and in ignorance of the conditions under which they were produced, is but to court failure, and still more so is it to fill up the incubator with foreign eggs.

The eggs should be the produce of hens, *and not of pullets*, mated, by preference, with a vigorous cockerel; they should be of uniform size, all abnormally large or small ones, and those of irregular shape, being rejected.

The necessary periods for the incubation of eggs, *both with the natural and artificial methods*, are as follows:—Hen, twenty-one days; pheasant and partridge, twenty-four days; duck and turkey, twenty-eight days; goose, thirty days. Some varieties of ducks—those approaching more nearly the wild state—also take thirty days,

## CHAPTER II

### An Approved Pattern of Hydro Incubator

THIS chapter will describe and illustrate the construction of a type of hydro or hot-water incubator, which has served as a model for manufacturers all the world over, and which has remained of substantially the same design

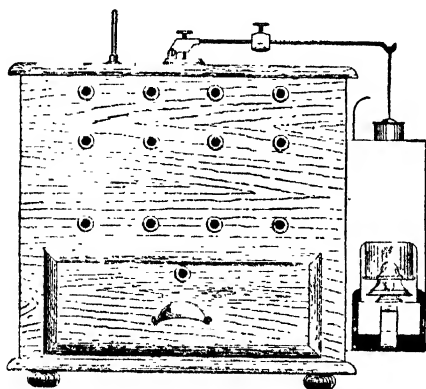


Fig. 5.—Front Elevation of 50-Egg Hydro Incubator

for between twenty and thirty years. It is based on a well-known Hearson type—the “Champion”—and it may be noted that Charles Edward Hearson’s incubator, of which the provisional specification was lodged in the British Patent Office on November 24th, 1881, and the complete

## INCUBATORS AND CHICKEN REARERS

specification on May 23rd, 1882, quickly came into high repute, chiefly because the inventor happened to hit upon what was at that time the only reliable regulator for maintaining uniform heat in the egg chamber. His "capsule regulator" is still the most popular type on the market.

A 50-egg Hearson-type incubator, with drying box, is shown by Figs. 5 to 10, under each figure being an explana-

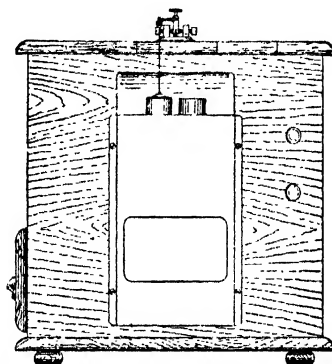


Fig. 6.—End Elevation of 50-Egg Hydro Incubator

tory inscription. The outer case is made of  $\frac{3}{4}$ -in. yellow pine, in the form of a square box 20 in. long, 20 in. wide, and  $17\frac{1}{2}$  in. from the top of the base-board to the underside of the top, dovetailed at the corners. Both base and top are also of pine, with the edges rounded, the base being in one piece. The top—apart from the glazed lid at the front—is in narrow widths, secured by round-headed brass screws, with washers under their heads. The opening

## HYDRO INCUBATOR

For the drawer,  $15\frac{1}{2}$  in. long and 5 in. high, is cut in the front of the case, 1 in. above the top of the base-board. On a level with the bottom of this opening is fixed the inner floor, on which the drawer slides. As shown, there is a  $\frac{1}{2}$ -in. space between the inner bottom and the base for ventilation purposes, the air passing in through four holes

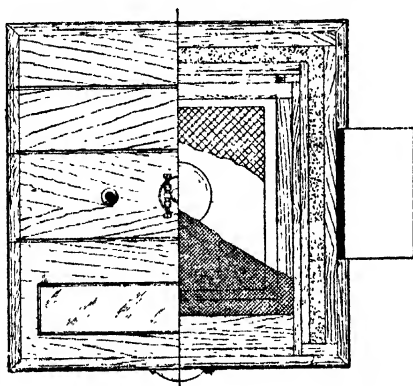


Fig. 7.—Part Plan of Lid and Part Horizontal Section through Egg Chamber

bored in the corners of the base, and finding its way into the egg chamber through a central hole in the inner bottom.

The water tank is 17 in. square and 4 in. deep, and is made of copper; it is traversed by a flue  $1\frac{3}{4}$  in. in diameter and 13 in. long from the outside of the water jacket, which extends to the outside of the case. The return flue is  $\frac{5}{8}$  in. from the other, and the two are arranged to occupy a central position, widthways, in the tank. Where they pass

## INCUBATORS AND CHICKEN REARERS

through the woodwork of the case and the packing, the flues are encased in a water jacket  $4\frac{3}{4}$  in. wide;  $2\frac{3}{8}$  in. deep, and  $1\frac{1}{2}$  in. long, the upper corners of which are quadrant shaped.

There is a false bottom, which may be of perforated zinc, arranged about  $\frac{3}{4}$  in. from the bottom of the tank.

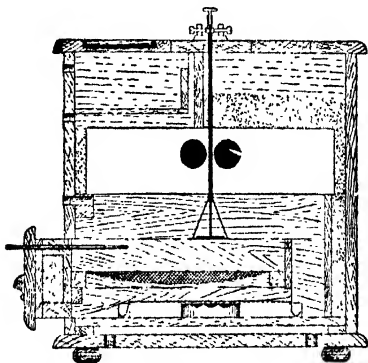


Fig. 8.—Vertical Cross Section through Centre of Incubator, with Drawer partly drawn

Between the top of the tank and the underside of the lid there is a space of  $4\frac{3}{4}$  in., and,  $8\frac{3}{4}$  in. from the inside of the front of the case, this space is partitioned off by a  $\frac{1}{2}$ -in. board running right across the case, and this forms a drying box for the newly hatched chickens. As seen in Fig. 8, a floor,  $\frac{3}{8}$  in. thick and  $7\frac{3}{4}$  in. wide, is fixed, distant  $3\frac{1}{2}$  in. from the underside of the lid; this allows a space of about  $\frac{7}{8}$  in. between the lower side of the floor and the top of the tank; to the edge of this floor a  $\frac{1}{2}$ -in. upright,

## HYDRO INCUBATOR

in. wide, is fixed, and along the upper bank edge of this upright piece a strip of coarsely perforated zinc is tacked.

In Fig. 5 three tiers of ventilation holes are shown, each tier being furnished with a  $\frac{1}{2}$ -in. brass eyelet; those in the lower row serve as outlet ventilators for the egg chamber—the inlets being through the base, as previously

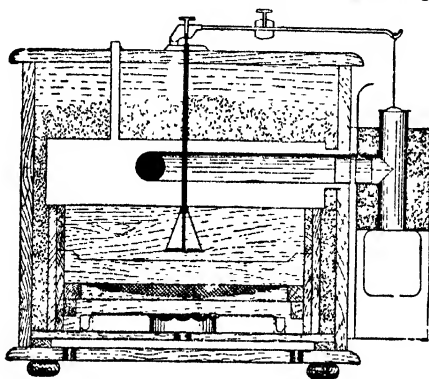


Fig. 9.—Longitudinal Section through Centre of Incubator

mentioned. A similar row of holes is provided at the back of the case, although they are not shown in Fig. 8. The middle row of holes serves as inlets for fresh air, which is warmed as it passes over the tank, and passed between the partition and the  $2\frac{1}{2}$ -in. upright piece, through the perforated zinc, into the drying box, finally escaping, laden with the moisture from the drying chicks, through the upper row of holes. The glazed lid, forming the front portion of the top, by which the chickens are introduced



## INCUBATORS AND CHICKEN REARERS

and removed, fits over the drying box, and is not fixed, but is kept in position by small fillets tacked to the underside

The opening which takes the egg drawer is  $15\frac{1}{2}$  in. wide,  $17\frac{1}{2}$  in. from the front of the case to the partition supporting the tank, and  $7\frac{1}{2}$  in. high from the surface of the inner floor to the bottom of the tank. The egg drawer is

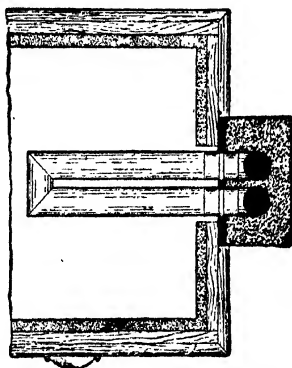


Fig. 10.—Part Sectional Plan of Incubator through Tank

an easy fit in the  $15\frac{1}{2}$ -in. by 5-in. hole cut in the front of the case, and is  $17\frac{1}{2}$  in. long from inside the false front, which, as will be seen, overlaps the drawer opening about  $\frac{1}{8}$  in. all round. The inside measurement of the drawer is  $14\frac{1}{2}$  in. square. The wood frame, which is covered with perforated zinc, and forms the bottom upon which the eggs rest during incubation, allows a space of  $1\frac{1}{2}$  in. round the sides of the drawer, and the concavity of this zinc

## HYDRO INCUBATOR

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bottom allows the eggs in the centre of the drawer to be 1 in. lower than those at the extreme sides.

For noting the temperature of the egg drawer, a hole is bored through the drawer front; outside it is bushed with a brass eyelet, and inside it is fitted with a paste-board tube of about  $\frac{3}{8}$  in. internal diameter, which projects  $\frac{1}{2}$  in. inside the drawer. The centre of this hole is  $\frac{1}{2}$  in. below the drawer top, and, when in use, the thermometer bulb projects slightly beyond the inner end of the paste-board tube, and is thus in the correct position for recording the heat reaching the whole of the eggs, the concavity of the bottom of the egg drawer compensating for differences of temperature which exist between the centre and the outsides of the egg chamber. The zinc water tray beneath the egg drawer is  $12\frac{1}{2}$  in. square, with sides 1 in. high and a hole 4 in. diameter in the centre. The inner inverted tray of coarsely perforated zinc which supports the damping canvas is 11 in. square and 1 in. high. Over this zinc support a double thickness of coarse canvas is used, and this is all round in the water contained in the tray, so all air passing into the incubator is filtered through the wet canvas and moistened in its passage. A single thickness of the dry canvas is used under the eggs in the egg drawer.

The heat-regulating apparatus, which includes a capsule, is fully described in Chapter VI. The bottom of the tripod, upon which the capsule rests, is  $2\frac{1}{8}$  in. from the bottom

## INCUBATORS AND CHICKEN REARERS

of the tank, and the needle tube which supports the tripod is arranged in the centre of the egg drawer.

The heating arrangements consist of a lamp box, 13 in. high, 8 in. wide, with a projection of 5 in. of which  $\frac{1}{2}$  in. consists of an air space between the lamp box proper and the side of the case. The upper portion of the lamp box, to a depth of  $6\frac{1}{4}$  in., contains in the front portion a  $\neg$ -shaped inlet flue, and in the back portion a  $\neg$ -shaped outlet flue, both  $1\frac{1}{4}$  in. in diameter. The flues in the lamp box are embedded in some non-conducting composition to connect them with the flue traversing the tank, a couple of nipples or connectors are employed,  $2\frac{1}{4}$  in. long, and of such diameter that they are a good fit in the flues, a reeded band being raised about the centre of each connector to prevent it being pushed wholly into one portion of the flue. Both inlet and outlet flues extend 1 in. above the lamp-box casing; and, to protect the woodwork of the incubator, the back of the lamp box is extended upward  $2\frac{1}{4}$  in. to form a shield, and the upper end is bent outwards to the extent of 1 in.

The lamp which supplies the heat is a rectangular vessel made of tinplate, 8 in. long, 4 in. wide, and 2 in. deep, mounted on and hinged to the back of a  $\neg$ -shaped casing of similar dimensions, but 3 in. deep. Beneath the lamp at the front end, and fixed to the bottom of the casing, is a spiral spring; in order to keep the spring in check, a square wire loop is hinged to the casing and

## HYDRO INCUBATOR

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passes over a catch soldered to the lamp reservoir. The burner is of the flat-wick type, but of somewhat special construction, obtainable from dealers in incubator fittings; it takes a  $\frac{3}{4}$ -in. wick, and is fitted with a gallery to accommodate a glass cylinder chimney, about 3 in. long and  $2\frac{1}{2}$  in. diameter, which serves as a connection between the lamp burner and the inlet flue in the lamp box. To place the lamp in position, the spring is depressed so as to allow the glass cylinder to pass into the opening in the front of the lamp box, on the bottom of which the lamp slides. When the lamp is pushed quite home the spring is released, and the glass cylinder then beds itself against the bottom of the upper portion of the lamp box so that the burner is immediately below the opening of the inlet flue, whilst the spring exerts its influence to keep the glass tightly in place. When the lamp requires to be trimmed or replenished with oil, it may be easily withdrawn by first depressing the spring.

For packing between the egg chamber and the case, and also round the tank, ordinary sawdust is employed, as indicated in the illustrations, and as these are strictly to scale, all minor measurements may be taken from them.

### Modifications and Suggested Improvements

In a modified form of the incubator above described, in the first place, the drying box is done away with—not because it is of no use, but because a foster-mother,

## INCUBATORS AND CHICKEN REARERS

described in Chapter IX., serves not only as a drying box, but also as a nursery in which to keep the chickens for the first few days of their existence before they are strong enough to be turned out into a rearer. There being no drying box, the height of the incubator between base and lid is reduced from  $17\frac{1}{2}$  in. to 15 in. in this machine, still

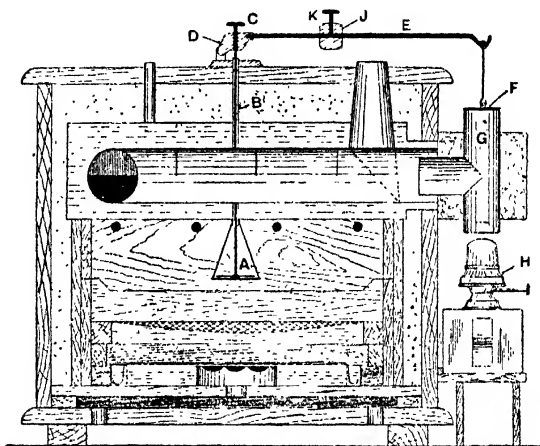


Fig. 11.—Longitudinal Section through Modified Hydro Incubator

allowing for 2 in. of cork-dust packing above the tank. Fig. 11 is a longitudinal section through the modified machine (the reference letters are explained in Chapter VI.)

The principal alteration and improvement will be found in the tank. This is 17 in. square, but  $4\frac{1}{2}$  in. deep, and is traversed by a flue,  $2\frac{1}{2}$  in. diameter, which is "baffled" at intervals throughout its length (see Fig. 12). In this

## HYDRO INCUBATOR

incubator as large a flue surface as possible is exposed, and the return flue, instead of being passed out at the side and into the lamp box, is turned upward near the

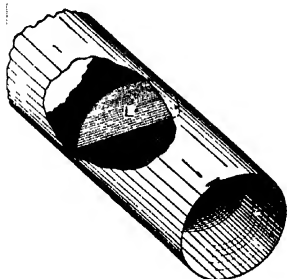


Fig. 12. Portion of Heating Flue, showing Baffle

end of the tank and passed out through the lid. The lamp box is constructed on similar lines to that shown by Fig. 13, and is  $4\frac{1}{2}$  in. square on plan and 4 in. high, and contains, quite centrally, a  $1\frac{1}{4}$ -in.  $\perp$ -piece or inlet flue, packed tightly in silicate cotton. The

lamp is a rectangular vessel 7 in. long, 4 in. wide, and 3 in. deep, upon which is mounted a "Silver" chimneyless burner taking a  $\frac{5}{8}$ -in. wick.

In this connection it may be worth mentioning that the collars into which the "Silver" burners screw are the same size for both the  $\frac{3}{4}$ -in. and  $\frac{5}{8}$ -in. sizes. In any lamp more perfect combustion is obtained when the flame is turned up as high as possible

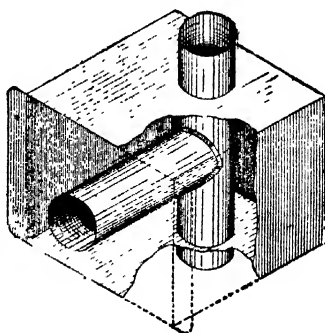


Fig. 13.—View of Lamp Box cut away to show Flue

## INCUBATORS AND CHICKEN REARERS

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without smoking. It is advisable to procure a burner of each size for this incubator, because a burner taking a  $\frac{3}{8}$ -in. wick is not powerful enough to keep up the requisite heat in cold weather; yet in hot weather it is almost impossible to keep a small enough flame in a  $\frac{3}{8}$ -in. burner, without a waste of heat; and when the flame is turned very low, a slight smell of unburnt petroleum vapour is perceptible, which, if not injurious, is at any rate unpleasant. (As a matter of fact, with incomplete combustion carbon *monoxide* instead of the *dioxide* is formed, and this is distinctly injurious.) This arrangement of lamp and flues will be found very economical.

Details of the regulator, ventilation, and damping arrangements, also of the egg drawer, are the same as already described, with the exception that, as the flue passes round the outer part of the tank instead of being in its centre, the heat from the tank is less central, consequently the egg drawer may be less concave. A nearly flat bottom to the egg drawer is desirable, but, if it is quite flat, the central eggs will get more heat than those nearer the outside. In the present instance, a dishing to the extent of  $\frac{1}{2}$  in. will suffice. The loose shutter will be found a great convenience, especially at hatching time, as it is possible to ascertain the state of the eggs without pulling out the drawer, with the consequent lowering of temperature. Also, should a chick get hung up in the regulator

## HYDRO INCUBATOR

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lipod—a not uncommon occurrence—it can be moved previous to pulling out the drawer, thus avoiding maiming, or the breaking of one or more eggs—a likely consequence when the cause of any obstruction cannot be seen, as is the case with a solid-fronted drawer.



## CHAPTER III

### An Easily Made 100-Egg Incubator

FIG. 14 shows an easily made 100-egg hydro incubator (with the front out) much as it should appear when ready for use. A is the tank; B is the regulating screw with damper rod and bracket; C is the drying box; D the hot-air tube; E the capsule and its stand; F the drawer front; G the moisture tray; H the circulator; J the lamp and tray; and K is the silicate of cotton packing.

No incubator will be found satisfactory unless it is constructed with an inner and outer case, since the atmosphere coming directly on to the eggs from the ventilation holes is injurious, as the eggs round the edge of the drawer frame will be found to be at least 4° F. cooler than those nearer the centre. For a 100-egg incubator, the outer case should be made of  $\frac{3}{4}$ -in. seasoned pine 22 in. square inside, the height, including top and bottom, being 18 $\frac{3}{4}$  in. The hole in front for the double-fronted drawer should measure 18 in. by 8 in., and the drawer front must be the full width of the machine, viz., 23 $\frac{1}{2}$  in. by 9 $\frac{1}{2}$  in., so that when closed the whole space in the outer case is covered. This drawer front having no stay may warp slightly, and to prevent this, insert in each end a piece

## 100-EGG INCUBATOR

pine the opposite way to the grain of the drawer front, and  $9\frac{1}{2}$  in. by  $1\frac{1}{2}$  in. by  $\frac{1}{4}$  in. To insert this piece, two cuts with a tenon saw  $\frac{1}{4}$  in. apart and  $1\frac{1}{2}$  in. deep must be made in each end of the drawer; then pass down a  $\frac{1}{4}$ -in. square chisel, which will remove the piece.

The most durable method of putting the case together is dovetailing. The dovetails must fit tightly, and be put together with thin glue, or they will be useless. The top and

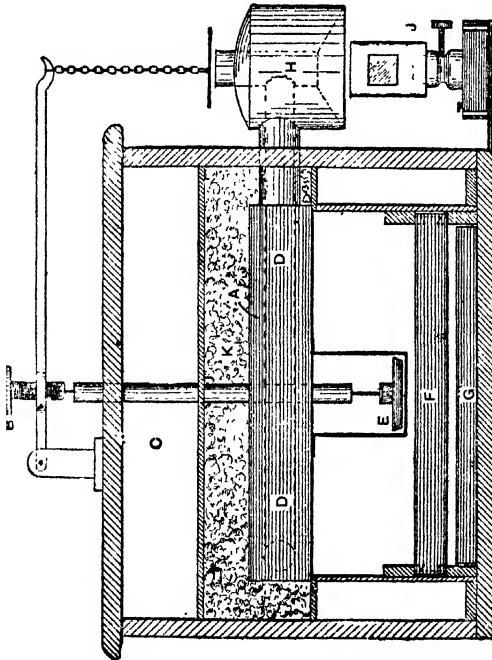


Fig. 14.—Longitudinal Section through Easily-made 100-Egg Incubator

## INCUBATORS AND CHICKEN REARERS

bottom must be screwed on, the screws being about 3 in. apart.

Ventilation holes in the outer case should be bored 4 in. apart,  $2\frac{1}{2}$  in. from the bottom of the tank, and  $\frac{1}{4}$  in. in size. A fillet of wood,  $\frac{3}{4}$  in. thick, should be nailed on each side on the bottom. The inner case should be 18 in. square, and 8 in. high, and should be screwed or nailed to the fillets fixed in the floor of the machine. Before fixing the inner case, set out the ventilation holes to con-

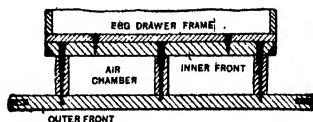


Fig. 15.—Section through Drawer Frame and Air Chamber

between the holes in the outer case; this is easily done by placing the inner case in position, and passing a pencil through the holes already drilled to mark the inner case. Then drill the holes exactly midway between the marks, and thus the necessary amount of ventilation is obtained and draught is avoided.

The drawer front for the inner case, 18 in. long and 6 in. wide, must fit flush with the inner case. This is simply a square wooden frame, and the bottom of the outer case forms the bottom of the inner one also. A fillet,  $1\frac{1}{2}$  in. by  $\frac{1}{4}$  in., must be fastened on each side of the inner case at the bottom, and on it runs the egg drawer. Another fillet

## 100-EGG INCUBATOR

ould be fixed 2 in. above it on each side, so that the drawer, which must be 2 in. deep (barely), will slide in and out easily.

The egg drawer is 18 in. wide by  $17\frac{1}{4}$  in. (barely) from back to front, thus allowing  $\frac{3}{4}$  in., so that the inner drawer fits flush. The inner drawer front will be 18 in. wide

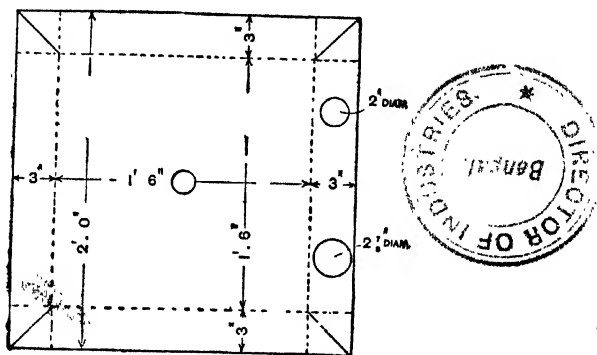


Fig. 16.— Pattern for Hot-water Tank

6 in. deep, and it is screwed to the drawer frame. See blocks of wood 6 in. long,  $2\frac{3}{4}$  in. wide, and 1 in. thick are placed between the inner and outer front, a 4-in. screw passed right through each block from the inside of the inner front and gripping the outer front to the drawer frame; see Fig. 15.

The egg drawer frame should be dovetailed at the corners, and a 1-in. equilateral triangle of wood should be glued and tacked in each corner. The bottom of the

## INCUBATORS AND CHICKEN REARER

frame should be covered with perforated zinc with  $\frac{1}{8}$ -in. holes, and tacked on to the frame with  $\frac{1}{2}$ -in. copper tape. It should be stretched as tightly as possible to give rigidity. The tank and hot-air pipes should be made of 6 sheet copper (the weight is that of a sheet 4 ft.  $\times$  2 ft.). The bottom and sides are made from one piece, and the corners are cut and lapped as in Fig. 16. The piece is cut to the full lines, and bent on the dotted lines at right angles. The corners will then lap, and must be well soldered outside and inside. To the  $\frac{3}{8}$ -in. hole in the centre a piece of copper tube 4 in. long is soldered. The 2-in. and  $2\frac{7}{8}$ -in. holes for the hot-air pipe should be cut while the sheet is in the flat, and the holes in the outer case should be cut when the tank is in position. The 2-in. hot-air pipes must extend from side to side of the tank, and be brought out at the 2-in. hole, a piece of  $2\frac{7}{8}$ -in. pipe, say 4 in. long, connecting the tank with the circulator. The T-piece is 2 in. diameter, and the top of the tank must be 19 in. square with a  $\frac{3}{8}$ -in. hole in the centre. The centre should be raised about  $\frac{1}{2}$  in., and a piece of  $\frac{1}{8}$ -in. pipe soldered beside the  $\frac{3}{8}$ -in. pipe to allow the air to escape. The  $\frac{1}{8}$ -in. pipe must be brought flush with the top of the machine which prevents the water getting air-locked, and ensures perfect circulation. The top of the tank should be turned down  $\frac{1}{2}$  in. all round, and well soldered in as the lid of a box. The 4-in. by  $\frac{3}{8}$ -in. copper tube now projecting through the lid must also be tightly soldered; on

## 100-EGG INCUBATOR

must the air-tube go inside the top of the tank, it must be soldered in the surface over a small hole in the highest part in the centre. A sheet-brass disk (Fig. 17) must be soldered on to the bottom of the tank to hold the capsule. It should be  $\frac{1}{2}$  in. wide and only  $\frac{1}{8}$  in. thick, a disk of tin being placed as shown to form a table for the capsule. A hole should be drilled in the centre of the disk, through the frame, for the pin in the capsule, and between the capsule and the disk

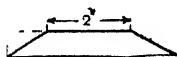


Fig. 18. — Diagram showing Dishing of Circulator

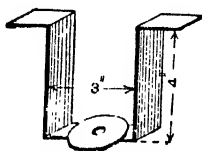


Fig. 17.—Capsule Stand

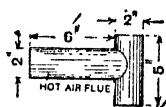


Fig. 19.—T-piece

should be put a piece of stout asbestos or cloth, as the heat conducted from the tank by the frame would cause the capsule to expand before the required temperature, only  $104^{\circ}$  F., was attained.

The circulator (H, Fig. 14) and the T-piece are made of sheet copper; the bottom is dished as in Fig. 18, and a 2-in. hole is left at the top to take the T-piece. The circulator is either dome-shaped or coned, to allow the air to accumulate, the tap being occasionally opened when the machine is started to allow any air or water to escape, when the water is heated it expands. A filling screw

## INCUBATORS AND CHICKEN REARERS

is soldered in the top of the circulator, and the tank filled through it. The T-piece (Fig. 19) is 5 in. long with a 6-in. projection, the hot-air flue being near the top. A  $2\frac{7}{8}$ -in. hole is cut in the side of the circulator, the top of the T-piece is threaded through it. The other end of the T-piece is now soldered to the projecting end of the hot-air flue in the tank, and the top and bottom of the T-piece are fixed in the top and bottom of the

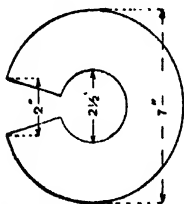


Fig. 20.—Pattern for Bottom of Circulator

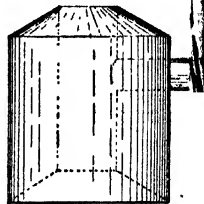


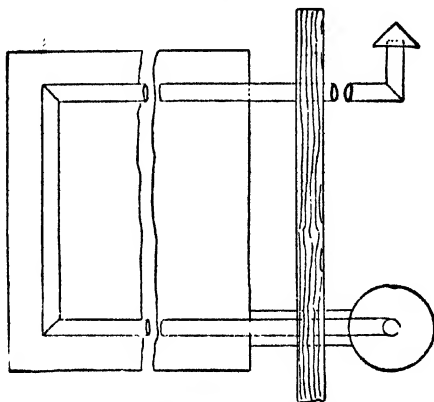
Fig. 21.—Cone-top Circulator

circulator, and the piece of pipe, 4 in. long by  $2\frac{7}{8}$  in. in diameter, is soldered over the  $2\frac{7}{8}$ -in. hole in the side of the circulator.

A cone-top circulator is made of 5-lb. copper. The jacket is made of a piece of sheet copper 5 in. by 17 in. in the flat; this is bent into a circle and the two edges well lapped and soldered. Prior to bending it, cut a 2-in. hole 3 in. from the top edge; this hole is to pass the long end of the T-piece through. Now cut a disk of copper 7 in. in diameter with a  $2\frac{1}{2}$ -in. hole in the centre; this disk must be dished. To obtain this shape it is necessary

## 100-EGG INCUBATOR

cut out a wedge piece 2 in. wide from the edge to the centre (see Fig. 20). The two edges are now drawn together, lapped, and soldered; the bottom is then ready to be soldered to the jacket, and the bottom of the T-piece soldered into the hole in the bottom. The top of the circulator is made in a similar manner, and of the same



\* Fig. 22.—Plan of Hot-air Flue

dimensions. The air-tap is soldered in the top of the circulator close to the centre, and should be left open when the tank is being filled, so as to prevent the water getting air-locked, which would prevent the water circulating. The centre hole will be 2 in. when the disk is drawn together. Fig. 21 shows the circulator.

The hot-air flue is carried from the circulator across the front of the tank, then along the side, and returns



## INCUBATORS AND CHICKEN REARERS.

across the back of the machine through the side of the tank, packing, and outer case, and projects, say,  $\frac{1}{2}$  in. or it may be turned up with an elbow and cap, as shown in Fig. 22. The flue can be made of 5-lb. sheet copper, Fig. 22 showing where the mitred joints occur. These mitred pipes must be well soldered together, and should be tested with boiling water before the flues are fixed in the tank to ensure the joints being sound; a leak will often show with boiling water but not with cold water, owing to the metal expanding when subjected to heat. Four strips of wood,  $2\frac{1}{2}$  in. wide and  $\frac{3}{8}$  in. thick, should be placed on the top of the inner case, so that they reach the outer case. On them rests the packing round the edges of the tank. The tank is now placed on top of these pieces so that there is a 2-in. space all round the tank, and this space is filled tightly with silicate of cotton or powdered cork or sawdust, silicate of cotton being preferred. The top of the tank should also be covered with the same packing. The circulator is now soldered to the piece of projecting pipe, which is 4 in. by  $2\frac{1}{2}$  in. The 2-in. hot-air flue is also connected to the T-piece in the circulator, as in Fig. 23.

The regulator rod with the cap on the end is sufficiently long for the cap to hang over the top of the T-piece in the middle of the circulator, so that when the cap is down, it alters the course of the heat, and passes it through the air tubes. A  $\frac{1}{8}$ -in. straight wire, sufficiently long to reach

## 100-EGG INCUBATOR

to a screw in the regulating rod, is placed on the capsule, the screw being about  $\frac{1}{2}$  in. from the hinge of the rod and hollowed at the end by a centre punch or small drill. The wire from the capsule is filed to a point to prevent the screw slipping off it, as shown in Fig. 24.

The lamp is of tin-plate, with a  $\frac{3}{4}$ -in. Queen Anne burner fixed about 1 in. from the end. It should be 20 in. long, 4 in. wide, and  $1\frac{1}{2}$  in. deep, and its top is cut and lapped at the corners the same as the tank, and then soldered

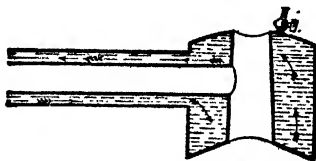


Fig. 23.—Joint of Hot-air Flue and T-piece

on a piece of flat tin  $20\frac{1}{4}$  in. long and  $4\frac{1}{4}$  in. wide, thus allowing  $\frac{1}{8}$  in. all round the lamp bottom for soldering. To show the quantity of oil in the lamp, a float is constructed of round cork  $1\frac{1}{4}$  in. by  $\frac{1}{4}$  in. thick. A thin wire is passed through the centre and is fixed in the cork by a piece of thin tin being soldered at the top and bottom of the cork. Place this in the lamp before putting the bottom on, and pass the wire through a small hole made at the top of the lamp about in the middle; this wire must work in a guide soldered on the lamp to prevent it bending when rising. A gauge is soldered close to this wire to show the height to which the wire rises when the

## INCUBATORS AND CHICKEN REARERS

lamp is full, and as the oil burns the wire will fall. The best guide is a piece of tube 1 in. long and  $\frac{1}{8}$  in. in diameter. A small piece of metal is soldered on top of this tube with a central hole, through which the wire passes easily. In fixing this float, get it upright, with the small holes in the lamp and pipe directly in line. The lamp is fixed to the side of the machine by means of a tin tray  $4\frac{1}{2}$  in. wide

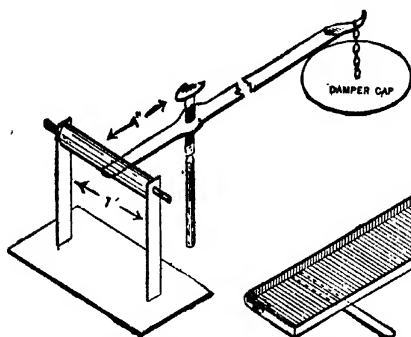


Fig. 24.—Regulator Rod, etc.

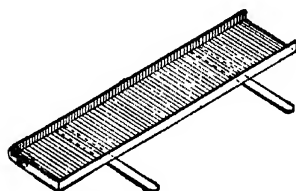



Fig. 25.—Lamp Tray

and  $20\frac{1}{2}$  in. long, turned up  $\frac{1}{2}$  in. at one end and bent at the sides. It is soldered to two pieces of iron 7 in. long,  $\frac{1}{2}$  in. wide, and  $\frac{1}{8}$  in. thick, and the ends of these stays slip in two square staples which are screwed on the bottom of the machine, so that it is easily removed (see Fig. 17). The chimney may be constructed of thin tin-plate with a piece of mica or talc let in its side. When in its place the top of the chimney is about  $\frac{1}{2}$  in. from the bottom of the centre of the circulator. Into this space the a

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ashes, and gets heated, causing a very quick draught through the hot air flues in the tank. A Queen Anne burner and collar can be obtained from any ironmonger's at a cost of about 8d., and a reliable capsule can be obtained from the dealers. The thermometer should be 12 in. long, and the section of it shows thus  which causes the mercury to appear nearly  $\frac{1}{4}$  in. wide.

The moisture tray is made of stout sheet zinc, say No. 11, and is 17 in. square, 1 in. deep, turned up 1 in. all round. This tray is half filled with equal quantities of bulk of sand and broken charcoal, saturated with water, and of course placed under the egg drawer on the bottom of the machine. This should be examined once a week, and kept moist.

When the thermometer registers 102° F., the regulating screw in the damper rod should be screwed down so that the cap in the middle of the circulator is raised  $\frac{1}{4}$  in.

It is possible to bend copper pipe by first softening it, making it blood-red hot, and plunging it into water. It then has to be filled with lead and hammered on a mandrel to the required shape. This is a long process, and requires experience, as the lead then has to be again melted out. It is mitred with far less time and trouble, and the result is quite satisfactory. Bending the pipe to the required angle may slit it, and hammering it makes the copper very hard,

## CHAPTER IV

### Making a 60-Egg Coil-heated Incubator

THE incubator illustrated in Figs. 26 and 27 is of a less usual type than those described in earlier chapters.

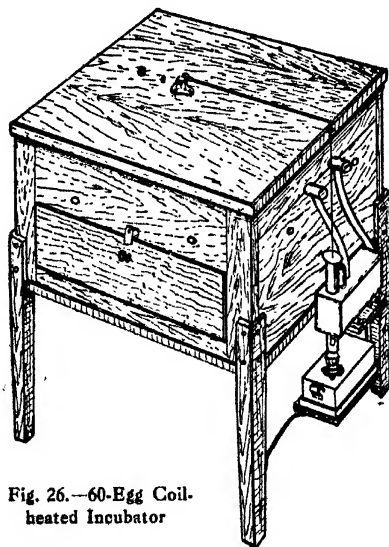


Fig. 26.—60-Egg Coil-heated Incubator

The

a piece of d by a circulatory system of hot-water pipe  
the top of them a boiler fixed outside the incubator wall  
of the centre of that by this arrangement a more equa

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temperature is maintained over the whole of the eggs by either the tank or the hot-air system, but, as many related matters, this is a moot point. However, markable results have been achieved by incubators built on this principle. Their advocates claim that whereas

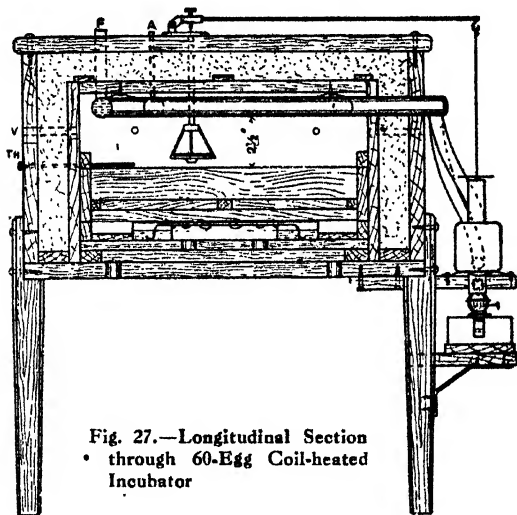


Fig. 27.—Longitudinal Section  
• through 60-Egg Coil-heated  
Incubator

In an ordinary tank machine the centre is always the warmest part, and those annoying cold corners and sides are well known, in the coil-heated incubator the pipes are arranged round the sides in such a manner that the centre of the egg drawer is heated by side radiation only. This arrangement tends to secure greater equality of temperature.

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Good, dry yellow pine is the best material for the woodwork. First make the drawer 1 ft.  $3\frac{1}{2}$  in. square inside of  $\frac{1}{2}$ -in. stuff  $2\frac{1}{4}$  in. wide. Make it exactly square outside, so that it may be taken right out and turned round side to front each time of turning the eggs, and so that any slight variations of temperature may have no ill-effect. At a distance of  $1\frac{1}{2}$  in. from the top, gauge

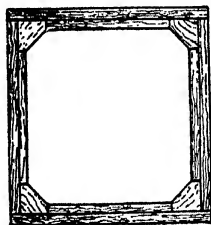


Fig. 28.—Egg Drawer Frame

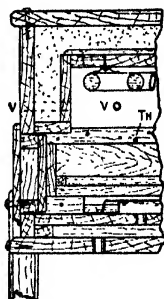


Fig. 29.—Part Cross Section of Coil-heated Incubator

a line, and below it fix corner brackets 3 in. by 3 in. by  $\frac{1}{2}$  in., and ledges  $\frac{1}{2}$  in. by  $\frac{1}{2}$  in. all along between them as shown in Fig. 28. Then nail a piece of perforated sheet zinc on top of these for the drawer bottom.

Next frame up the inside walls, which are  $\frac{1}{2}$  in. thick and  $10\frac{1}{2}$  in. wide, for one side and the back, the right hand side being made  $1\frac{1}{2}$  in. narrower, so that the coil can be put in place later, a piece  $1\frac{1}{2}$  in. wide being used to make up to the full width. Make the inside width

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the working fit for the drawer, and extend the sides 1 in. the front longer than the drawer, to allow for the door thickness. Nail a bar 1 ft. 4½ in. by 4 in. by ½ in. across between the sides at the front level with the top edge, and a strip of equal length 2½ in. by ½ in. at right angles in the first, as shown in Fig. 29. These serve to hold the packing over the doorway. Seven and a half inches down from the top, nail strips of about ½ in. by 1 in. section

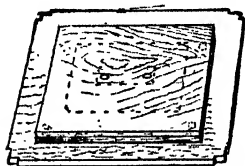


Fig. 30. --Outer Bottom

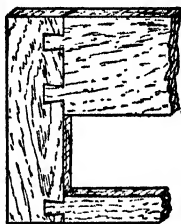


Fig. 31. --Egg Drawer Frame

on both sides to carry the egg drawer which runs on them, and nail two pieces above the drawer. Make the outer bottom of ¾-in. thick material and 1 ft. 11½ in. wide by 1 ft. 10½ in. deep from front to back. Cut away 1½-in. by ½ in. strips from both sides of each corner to take the eggs, as shown in Fig. 30.

To the bottom, nail ledges 1 in. by ¾ in. thick all round ¾ in. from the ledges, except at the front, where it comes 1½ in. of the edge. On these will rest the inner bottom to form the air space for ventilation. The inner bottom measures 1 ft. 5½ in. by 1 ft. 4½ in., and is of stuff



## INCUBATORS AND CHICKEN REARERS

Bore four ventilation holes  $\frac{1}{2}$  in. in diameter in the outer bottom  $5\frac{1}{2}$  in. from the edges for centres, and two through the inner bottom centrally at 4-in. centres and of  $\frac{1}{2}$  in. diameter. Nail the inner bottom down on the ledges. The inner walls should now be placed in position, and should fit outside the ledges, coming flush in front. Nail them to the ledges and up through the outer bottom, and fix distance pieces  $1\frac{3}{4}$  in. by  $\frac{1}{2}$  in. at the back and sides flush with the front, to keep the outer walls correctly spaced.

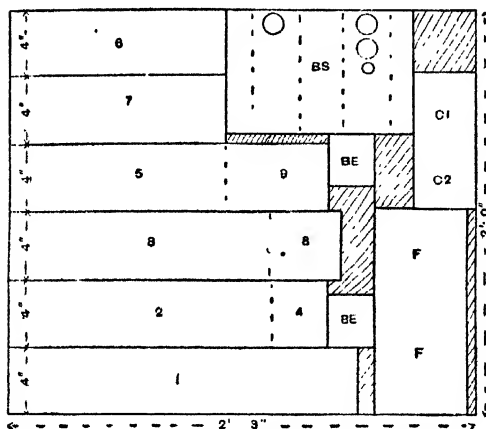
Frame up the front, dovetailing as shown in Fig. 25, to leave the doorway matching the inside walls for width about 1 ft.  $4\frac{1}{2}$  in. and 5 in. wide. The front measures 1 ft.  $10\frac{1}{2}$  in. wide by 1 ft.  $\frac{1}{4}$  in. high, and should have a bottom bar of equal height with the inside bottom. Make the door of double thickness, leaving a space of  $1\frac{1}{4}$  in. between, which can be packed with sawdust. The outer thickness must lap  $\frac{1}{2}$  in. all round. Hinge the door at the bottom, and fix a button at the top, as shown in Fig. 26.

Make the outer side walls of  $\frac{7}{8}$ -in. stuff, 1 ft.  $8\frac{1}{2}$  in. long by 1 ft.  $\frac{1}{4}$  in. wide; but the right-hand side (the boiler side) should be jointed at the same height as the inner walls. The back should be made of equal width and 1 ft. 9 in. long. Well nail them together with the back piece inside the others; but leave out the top loose piece of the side, which should be secured with a couple of screws at each end later on when the coil has been

## COIL-HEATED INCUBATOR

ly tested and secured in place. Screw the front in place.

Now make the inside top 1 ft. 4½ in. square by ½ in., fix three ledges, 1¾ in. by ½ in., to project ½ in. each and in the positions shown in Figs. 27 and 29. When



**Fig. 32.—Laying out Copper Sheet for Boiler, Pipes, etc.**

placed in its place inside the inner walls, the inside top rests on these ledges at the sides and ends.

Make the water tray 11 in. square by  $1\frac{1}{4}$  in. deep, the total ventilation space being 6 in. by 2 in., place in position, and nail strips of  $\frac{1}{4}$  in. stuff all round except the bottom, as shown in Fig. 27.

Procure a piece of 8-lb. sheet copper 2 ft. 3 in. by  
., which will be sufficient to make the coil pipes and

## INCUBATORS AND CHICKEN REARER

boiler complete, and cut up as shown in Fig. 32. The copper sheets are made 4 ft. by 2 ft. of various weights. This particular gauge will therefore run 1 lb. to the square foot, and should be bought for about 1s. per pound. No. 1 pipe (see Fig. 32) is made from a copper strip 1 ft. 8 in. by 4 in. In Fig. 33 all the pipes will be found numbered off, and the pieces marked out in Fig. 32 correspond with these numbers. Some of these pieces are long enough to make two pipes, in which case a saving of material is effected by cutting the resulting pipe in two on the middle, which these lengths are calculated for. Bend the plates one at a time round a broom handle or other similar rounded stick, tapping them into shape with a mallet. Clean the two adjacent edges, tie a piece of string round each end to hold the bent plates to  $1\frac{1}{4}$  in. diameter, then run the soldering fluid well into the joints, which should now have about  $\frac{1}{8}$ -in. lap, and solder up, making a thorough job of them, as, of course, they must be quite watertight.

Cut them on the mitre with a fine saw to the length and positions of angles shown in Fig. 33. File the ends until they will fit their respective partners to form correct right angles, clean up all round the joints inside and outside and well solder as before described. As each corner is finished, test it with hot water in the angle, filling the pipes as full as possible, and rectifying any leakage before proceeding farther.

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Put them together as finished on a level board (and one is the inside cover, on which the coil may be bent out), so that the finished coil shall be on one plane. Drill a  $\frac{3}{4}$ -in. hole for the filling pipe at mid-length in pipe No. 2 before bending it, and drill a  $\frac{1}{4}$ -in. hole for the air pipe in pipe No. 6. When all the pipes are assembled and soldered up, stop one end with a suitable copper cap,

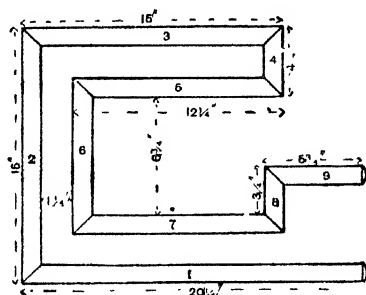


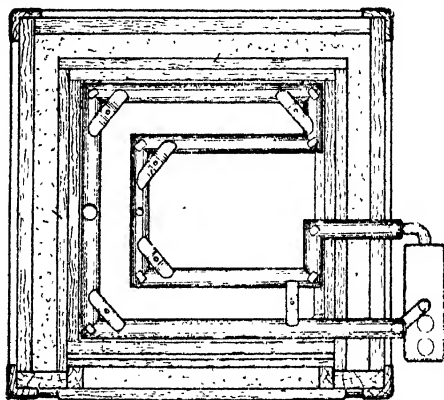
Fig. 33.—Circulating Coil

Order the air and filling tubes in place (which are each 12 in. long), plug them with wood, and fill the coil with water at the open end. If any leak shows, resolder and test again until correct. Then solder a cap on the other end of the coil, and bore two  $\frac{3}{4}$ -in. holes in the under side of the coil as near as practicable to the ends. In these holes the flow-and-return pipes from the boiler will afterwards be fixed.

Cut a number of small pieces of copper  $\frac{3}{4}$  in. by  $\frac{1}{2}$  in. to form strengthening gussets, and solder them across

## INCUBATORS AND CHICKEN REARERS

the angles above and below, as shown in Fig. 34. This will greatly assist the strength of the angles. Now cut six strips of copper, zinc, tin-plate, or brass 3 in. by  $\frac{7}{8}$  in. and bend them to the shape shown in Fig. 35 to act as hangers for the coil. They should hold it  $\frac{1}{2}$  in. below the inside top. Drill a screw hole in each, and solder them



--Horizontal Section through Coil-heated Incubator

Paint the coil angles as shown in Fig. 34. Give the whole coil, more especially the under surfaces, a good coat of lampblack mixed with methylated spirit and just sufficient shellac to hold it together. Or mix turpentine and little gold-size or oak varnish with the lampblack. In any case, it should dry a dead black, as this material assists the radiation of heat from the coil surfaces.

Lift off the inside top board, if the coil has not been

## COIL-HEATED INCUBATOR

it on it, and screw the coil in its place, allowing  $\frac{1}{4}$ -in. margin all round between the edges of the board and the post. Replace the board, and mark the position of the slots to be cut in the inner and outer walls on the right-hand side for the coil pipes to pass through. The bottom of the coil should now stand  $2\frac{1}{2}$  in. from the drawer edge, as shown in Fig. 27. Cut them out to fit, and the frame is ready for the boiler.



Fig. 35.—Coil Hanger

Fig. 36.—Leg cut to fit  
Corner of Incubator



Meanwhile glue-joint the  $\frac{3}{4}$ -in. boards for the outer cover, which is of equal area with the outer bottom. Plane up, and bore the holes for the air and filling pipes of the boiler to pass through. Fit in place, and screw down with  $1\frac{1}{2}$ -in. bottom or round-headed screws. Procure a right incubator thermometer about 7 in. long, bore a hole through the left-hand side of the incubator on the level of the drawer top (see TH, Figs. 27 and 29), which should be about the egg level, sufficiently large to allow a thermometer to be fixed across the two walls. It should be an exact fit for the thermometer, and also prevent the sawdust from choking the hole.

## INCUBATORS AND CHICKEN REARER

Bore two  $\frac{1}{4}$ -in. holes in each of the four sides through the double walls for ventilation. They should be about  $1\frac{1}{2}$  in. down from the bottom of the coil to the centres. Get a  $\frac{3}{8}$ -in. round stick or tube 1 ft. long, and roll some glued paper round it to form a couple of paper tubes to fit the ventilation holes. When dried and these will cut up into eight ventilation tubes, which should be glued across from wall to wall in the holes bored previously to receive them (see v, Fig. 27). Procure a quantity of coarse dry sawdust, raise the outside to and tightly pack all the packing space with the dust.

The capsule regulator now requires attention. The whole thing may be bought complete for a few shillings and this is really the best thing to do. But for those who wish to make their own, full instructions are given in Chapter VI. In this machine the needle tube of the regulator from which the capsule bracket is suspended should be sufficiently long to hang  $\frac{3}{4}$  in. below the coil and should be screwed or soldered securely to the bracket plate on top; there being no tank to secure it to, the support is necessary. Its bottom end is screwed to the capsule bracket thread. Bore the necessary holes to receive the regulator at about the position shown in Fig. 1 and fix it in place.

Plane up four legs 2 in. square and 1 ft. 7 in. long, from a point 7 in. down from the top, taper them to 1 in. square. Gauge off  $\frac{1}{8}$ -in. thickness on two edges at

## COIL-HEATED INCUBATOR

end, and cut away between them for 5 in. down (*see* 36), so that they may fit the incubator corners, and w them securely in place at the four corners.

The next part is the boiler. This type of horizontal er has been specially designed for this incubator. It been arranged to give a flue area as long and large possible. The whole thing is made of the same gauge per as the circulating pipes.

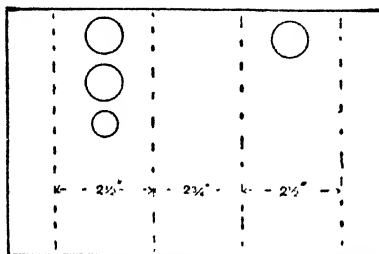


Fig. 37.—Plate Diagram for Boiler Shell

Cut out the plate for the shell  $7\frac{1}{4}$  in. by  $10\frac{3}{4}$  in., mark the three holes for the two chimneys  $1\frac{1}{8}$  in. in diameter, the exit water-pipe hole  $\frac{3}{4}$  in. across. The  $1\frac{1}{8}$ -in. hole like the bottom of No. 1 chimney must also be cut. These should be spaced as indicated in Fig. 37. Plane block of soft wood 9 in. by  $2\frac{3}{4}$  in. by  $2\frac{1}{2}$  in., and round off the corners. Bend the plate carefully round this the 7-in. side lengthwise, so that the lap seam shall be e of the sides and the holes central at the top; but t now solder it. Next prepare the flues. Cut out



## INCUBATORS AND CHICKEN REARER

the copper for these in one length 12 in. by  $5\frac{1}{2}$  in., lay round a block of  $1\frac{1}{2}$ -in. by  $\frac{1}{2}$ -in. section, clean up with glasspaper or by scraping with a knife both surfaces of joint, and carefully solder up watertight.

Now mark off the lengths as shown in Fig. 38, and with a fine saw cut them across at a mitre angle of  $45^\circ$  while still in position on the wood. File up the joints to go together at right angles, and see that the two horizontal



Fig. 38.—Cutting Boiler Flues

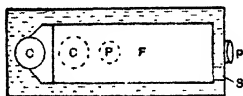


Fig. 40.—Horizontal Section through Boiler

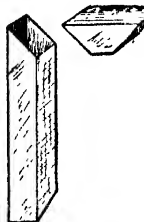


Fig. 39.—Mitre Joint of Flues

flues are parallel  $\frac{1}{2}$  in. apart. The mitre joint is shown at Fig. 39. Cut the  $1\frac{1}{2}$ -in. hole in the shorter top flue for the No. 2 chimney, and shape the corresponding end of the longer bottom flue to fit into the No. 1 chimney as shown at Figs. 40 and 41.

Make both chimneys in one 8-in. length out of a  $3\frac{1}{2}$ -in. wide plate. Cut out the slot for the flue connection as in Fig. 42, also the  $\frac{1}{6}$ -in. square peep-hole for the lamp flame, roll round the broomstick, clean the edges, and solder watertight. Cut off a length of  $2\frac{1}{2}$  in. for No.

## COIL-HEATED INCUBATOR

in the end without the hole, and carefully fit the opening No. 1 to the lower flue. Solder them tightly, and close up the two side gaps formed by cutting away the metal tapered down in width to the chimney diameter

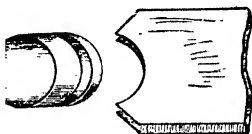


Fig. 41.—Joint of Chimney and Flue

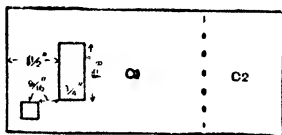
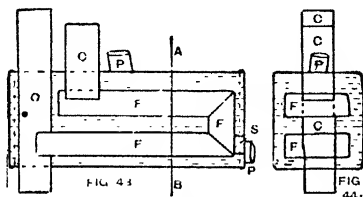


Fig. 42.—Plate for the Two Chimneys

about  $1\frac{1}{8}$  in.). Small scraps of copper plate cut to fit and soldered in place do nicely. Next fit No. 2 chimney in its place in the top flue. Clean the joint, and solder in position  $\frac{1}{4}$  in. down in the flue, as shown in Figs. 43



Figs. 43 and 44.—Horizontal Section and Cross Section through Complete Boiler

44. This serves as a baffle to keep the flue full of air. Fit a piece of plate across the open flue end and solder. The letter references in Figs. 40, 43 and 44 agree. The flues and chimneys are now complete, and should be carefully tested for watertightness. Then fix them

## INCUBATORS AND CHICKEN REARERS

in the boiler shell, by spreading it partially open and coaxing them into their respective positions, and soldering them so that the spaces between the flues and shell at the bottom and top are respectively  $\frac{1}{4}$  in. and  $\frac{1}{2}$  in. In Figs 42 and 43, s is a short pipe  $\frac{1}{2}$  in. in diameter passing into the flue, which is corked when in use, and is intended as a sweep-hole should the lamp smoke at any time.

Two plates, 3 in. by  $2\frac{3}{4}$  in., will be required for the boiler ends. In one of them cut a  $\frac{3}{4}$ -in. round hole  $\frac{3}{8}$  in. from the bottom edge centrally. Place them against the ends of the boiler shell, so that they project  $\frac{1}{8}$  in. all round. Mark with a scribe, bend the edges down at right angles, so that they fit the shell, scrape the joint and solder. All the boiler joints should be carefully made, tested with water step by step, and also when finished. Should any difficulty be experienced in soldering the inside angles of the short flue, the space being rather small for an ordinary soldering bit, place some bits of solder in the corners, wet with fluid, and use a blowpipe on them, or the tapered square end of a worn kitchen poker made red-hot, as did the writer. Screw the boiler shelf, which is 5 in. wide, underneath the incubator to project 5 in.

Two strips of plate  $\frac{3}{8}$  in. wide should be cut for feet and drilled for  $\frac{1}{2}$ -in. screws, bent as shown in Fig. 35, and soldered in position about  $2\frac{3}{4}$  in. apart. Now screw the boiler to its shelf, leaving the chimney well clear as shown.

## COIL-HEATED INCUBATOR

All is now ready to connect the boiler up with the incubator so that it stands on its shelf  $1\frac{3}{4}$  in. from the incubator and about  $6\frac{1}{2}$  in. below, measuring from the bottom of the coil to the boiler top. Use ordinary thin copper or brass piping, bent to suit the positions as shown in Figs. 26 and 27, and solder the pipe from the boiler top to the front right pipe of the coil. This carries up the hot water circulation, while the pipe leading from the other end of the coil to the boiler end of the bottom brings the return current of cooler water back for reheating and recirculation. Use plenty of solder to strengthen the pipe connections. If screw union joints are used at one or both ends of the pipes, they are easily detachable for transit, but are not needed for use.

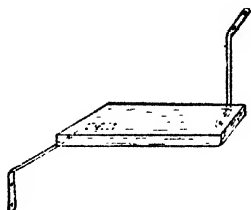


Fig. 45.—Method of Securing Lamp Shelf

A  $\frac{3}{4}$ -in. Silver chimneyless burner is required for the lamp, which measures 7 in. by 4 in. by 2 in., and should be fitted with a handle as shown in Figs. 26 and 27. Its handle should be screwed  $\frac{3}{4}$  in. lower than the lamp should stand, a packing block being provided of that thickness. The method of securing this shelf by means of two  $\frac{3}{4}$ -in. round brass brackets is shown in Figs. 26 and 45. When the lamp is lifted until the burner fits up against the chimney, the packing block should just slide in place, and must, of course,

## INCUBATORS AND CHICKEN REARER

be removed when the lamp is taken away. The lamp flame may be easily seen for regulating through the small square cut out of the chimney, and glazed with a section of mica sheet  $\frac{3}{8}$  in. square. The mica is held in position by the four small strips (see Fig. 42), one on each side being cut free at each side and bent outwards. The mica is then placed in position, and the bent strips pressed back in place; these hold it firmly. When the damper is closed down on  $c_1$ , the heat passes into the flues to escape at  $c_2$ . When the damper opens, the heat leaves at  $c_1$ , and so allows the water to cool.

Now place the capsule regulator rod in position on  $c_1$  chimney, cut it to length, solder on a small hook for suspending the damper, and cut a wire to the correct length for the damper to rest on  $c_1$ , not forgetting a loop in its top end, to be slipped over the regulator rod hook as shown in Fig. 27.

Into the filling tube F (Fig. 27) place a funnel, and proceed to fill the coil and boiler with hot water, keeping a sharp look out for any leaks. Should any appear, unscrew the boiler feet and lift out the coil and boiler carefully for inspection. Mark the leaks with chalk, pour off the water, and thoroughly resolder the defective joints. Replace the coil in position, screw down the boiler feet, refill all with hot water, meanwhile tilting the incubator to and fro, so that all air shall be passed out at the hole A (Fig. 27) and the filling hole.

## COIL-HEATED INCUBATOR

When the water begins to rise in the filling tube, stop filling, fill the lamp with oil, and light up. The hot rent will soon be circulating through the pipes, and expansion as the heat increases, will probably overflow a little at the filling pipe. This must be watched a sponge or cloth kept handy for mopping; but a safer way is to have a small syringe ready at hand, and with this suck up a little as it threatens to overflow.

When the temperature is quite up, the tube F (Fig. 27) must be kept nearly full, for this acts as a cistern to keep the coil full of water, which is essential for free circulation. Water must not get into the pipes, and cannot while the pipe is full of water. While in use, a little water must be added occasionally, as it evaporates from the coil heat.

Increase the heat until the thermometer at the side shows  $103^{\circ}$  or thereabouts, then allow all to warm up a couple of hours. It will then be time to regulate the machine. •Open the draw door, place the capsule in stirrup, being careful that its bottom stud is passed into its receiving hole. Pass the regulator needle down the tube until it rests securely in its appointed depression on the capsule top. Mark off at the top the correct length of the needle, cut off with a file, and place the regulator cover it. Turn down the regulator screw until it rests on the needle, and continue until the damper begins to blow off  $C_1$  at  $103^{\circ}$ , by the thermometer below.

The correct hatching heat is about  $104^{\circ}$  on the eggs,

## INCUBATORS AND CHICKEN REARERS

and the better to ensure this it is well to have an extra thermometer to be used actually resting on the eggs. A cheap clinical one is best, as it registers the maximum heat permanently until the mercury is shaken down again. This may be moved about to different parts of the drawer while in use, and will show any variations of heat. It is also an effective check on the other thermometer and through its checking it may be found necessary to run the machine at a higher or lower temperature shown on the side thermometer, to ensure the correct 103° or 104° on the eggs. This point cannot be too strongly emphasized as machines are often run correctly to their thermometer but may be 2° or 4° colder on the eggs.

To prevent waste of heat from the boiler by radiation it should be covered with two thicknesses of loosely woven sacking, such as is used to make potato and onion sacks. This should be fitted tightly to the boiler, slitting the stuff where the chimneys, pipes, and feet project, passing the material round them, and sewing it all snug and tight. Cover the coil connection pipes also in the same manner. In a ten-cup mix 2 parts of whiting to 1 part of Portland cement, and add water while mixing until like thick cream. Spoon it on to the sacking, rubbing well in with the finger and finishing it off smoothly all over. When dry it will form a hard, non-conducting covering, and will well repay the little extra trouble involved, by the saving of oil required for heating.

## COIL-HEATED INCUBATOR

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Give the woodwork of the finished machine outside a coat of shellac varnish, into which has been dissolved sufficient bismarck brown to make it a rich, deep red color. When dry, give two further coats of the varnish without stain.

In use, it is an easy matter entirely to pull out the egg drawer during the process of turning the eggs, and closing the hinged door to retain the incubator's heat. It is the eggs that require cooling, not the incubator. This point is often overlooked. Its advocates claim that even when the machine is cooled down, this form of incubator will warm up far more rapidly than any other hydro machine, because of the comparatively small bulk of water. It will also be found very economical indeed for oil fuel.

When returning the drawer to the incubator, it is a good plan to turn it round, front to side, each time, in case the temperature of different parts varies a trifle. This is rendered easy by the drawer being made square for this purpose.

See that the water is always visible in the filling tube, adding a little occasionally as it evaporates, full pipes being essential to a good circulation.



## CHAPTER V

### A New Design of Hot-air Incubator

THIS handbook would not be complete if it did not treat on the practical construction of a hot-air incubator. The machine—the “Mezna”—here selected for description is not of the customary hot-air type, but is a new and special design, originated by Mr. Lionel Hall, a British maker and also an experienced poultry breeder, who has been particularly successful in artificial incubation for the “day-old chick” business. He is confident that a machine giving better results at the same cost and more easily managed is unobtainable at the present time.

This machine does away with the long winding flue pipe, which is so difficult to clean and the fouling of which causes an increase in fuel consumption. Often the flame is raised dangerously high, this causing soot to deposit in the flue, and so makes matters worse. The machine here described and illustrated is not just an improvement along well-known lines, rather is it a distinct type by itself. Instead of the huge tank and intricate flues, a hot-water circulating tube is employed instead, the flame from a smaller lamp being ample to hatch large quantities of eggs. There are no parts to get out of order, no intricate

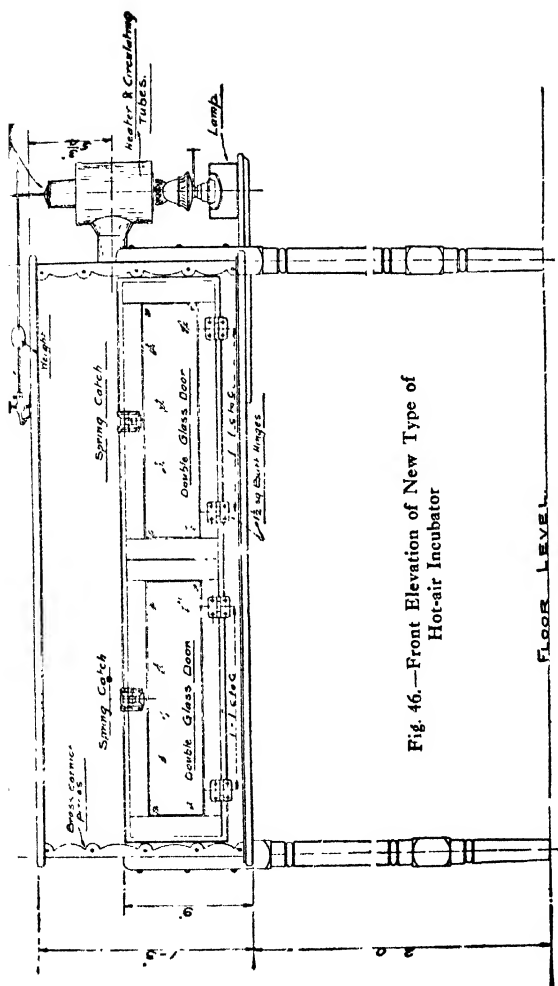


Fig. 46.—Front Elevation of New Type of Hot-air Incubator

## INCUBATORS AND CHICKEN REARE

construction that can get out of repair, and the boiler, flue, and circulating tube are all in one piece, making everything less complicated. By this system two difficulties are overcome. The flue being only 6 in. in diameter it is easily cleaned, and the temperature in cold weather is maintained satisfactorily. The inventor has patented this new system of heating, but readers of this handbook are quite at liberty to construct the machine for use, but not for sale. The inventor supplies all parts and fittings that cannot be made at home. Inquiries should be addressed to Lionel Hall, Causeway, Fishponds, Bristol.

The machine is very fully illustrated by Figs. 46 and 47, under each of which is an explanatory inscription.

The chief materials used will be  $4\frac{1}{2}$ -in. by  $\frac{5}{8}$ -in. V-shaped matchboard, 3 in. by  $\frac{3}{4}$ -in. wood for the framework, and millboard or strawboard for the inner case, flocking, packing, the various fittings, and 6 lb. or 7 lb. sheet-iron for the heating tube.

Make the two ends of the incubator first, by constructing from 3-in. by 1-in. timber two frames 2 ft. 6 in. by 1 ft. 3 in. These frames, halved together, are covered with V-shaped matchboard, using panel pins as nails; they will drive easily, and the small heads can be punched in. Plane the frames square. By using narrow matching shrinkage will not be noticed; but if glue joints are made, or wide boards used, they so often crack or joints open. The narrow V-matchboard will cost less, and always remain good.

## HOT-AIR INCUBATOR

es, the difficulty of making a glue joint is avoided.  
 all the lengths (3 ft. 6 in.) of matchboard for the back.  
 ove a groove or tongue, and plane square. Nail this

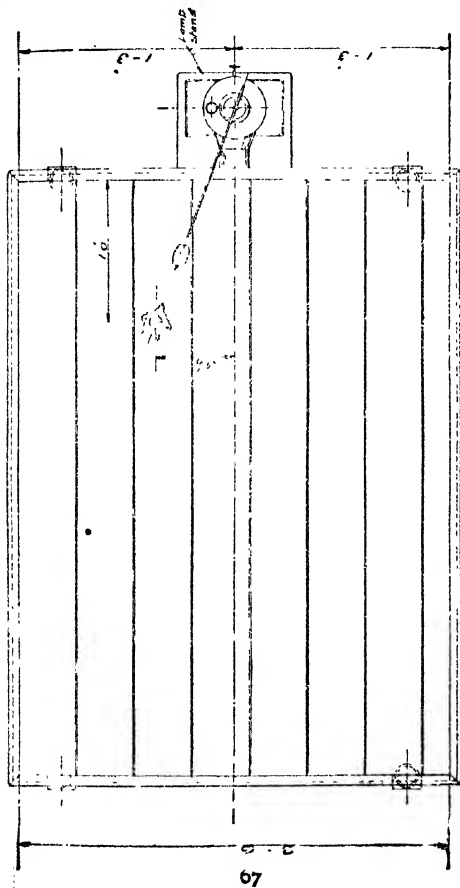


Fig. 47.—Plan of New Type of Hot-air Incubator

## INCUBATORS AND CHICKEN REARE

on to the two sides, and board up from the bottom. the work on its back, and nail a trued-up piece of by  $\frac{1}{2}$  in. on the top part of the front, and a strip 3 in  $\frac{1}{2}$  in. on the bottom of the front. There will be left an

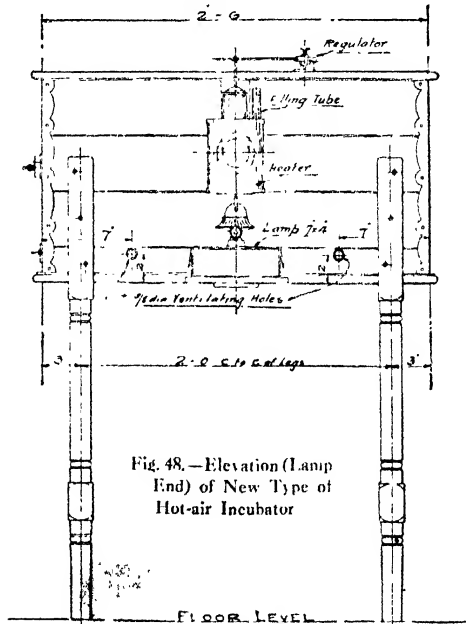


Fig. 48.—Elevation (Lamp End) of New Type of Hot-air Incubator

space of 6 in. along the front, which will be filled in later with the two doors. Lay the structure on the ground bottom up, and see it is quite square, then board over with  $\frac{1}{2}$ -in. matchwood.

Make the two  $\frac{3}{4}$ -in. ventilating holes, as seen in Fig.

## HOT-AIR INCUBATOR

It will be placed 7 in. from the front and 2 in. from the side, and the other 7 in. from the back and 2 in. from the bottom. Cut away a channel from the 3-in. by  $\frac{3}{4}$ -in. so as to give a free passage of air to enter the incubator through the inner side. On the left-hand side, or opposite end of the machine

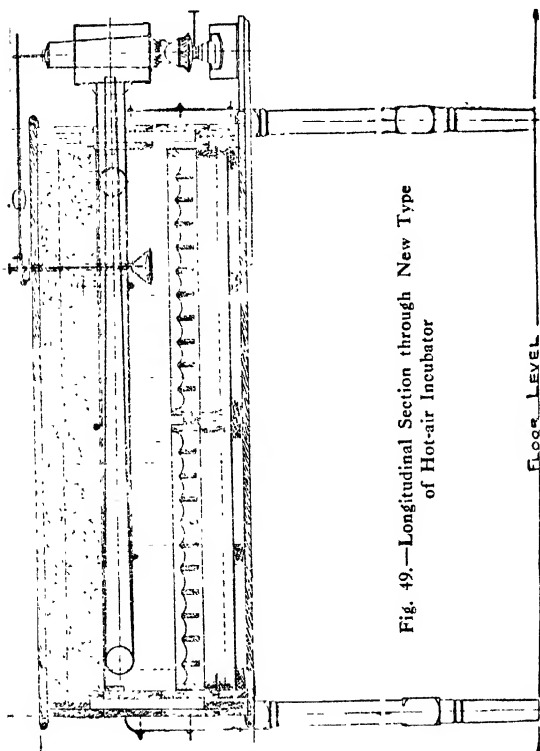


Fig. 49.—Longitudinal Section through New Type  
of Hot-air Incubator

## INCUBATORS AND CHICKEN REARE

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put one hole 7 in. from the back and 7 in. off the bottom and another 7 in. from the front and 7 in. off the bottom.

Next lay a strip of 3 in. by  $\frac{3}{4}$  in. up the centre of the back, and nail a strip of the same material on the inside against the two sides, and along the top and bottom. This is to fix a piece of millboard on, thus giving a narrow space between the two backs. Lasting tacks, or "ting" as used in the boot trade, will be best to fix the millboard on with.

With  $\frac{5}{8}$ -in. matchwood cover the two inner sides from bottom to top, keeping the front edge flush with the inside of the front. Before nailing this in, the inner ventilating holes must be made. On the right or lamp side the holes will be 7 in. from the front and back and  $6\frac{1}{4}$  in. from the inside bottom. On the other or left side, the holes will be 1 in. from the inner bottom and 7 in. from the back and front. When these holes are all made and the channels proved to be clear, nail in the sides.

It will be now observed that air enters at the lamp side of the machine, through holes 2 in. from the bottom into the incubator at openings 7 in. from the front and back and  $6\frac{1}{4}$  in. off the bottom, across the heated channels downward, through two holes 1 in. off the bottom at 7 in. from back and front. (Reference to the illustration will show what is meant.) These two holes will be made through the runner of the egg drawer, into the air space upward and outward through two holes in the outer

## HOT-AIR INCUBATOR

When the machine is complete, four circular plates, of pennies, can be made. A hole should be drilled in each, close to the side. A small rose-headed screw will fix this, as a revolving hinge, over each vent-hole, so that the plates can be moved to make the aperture close. To give more moisture during incubation, close

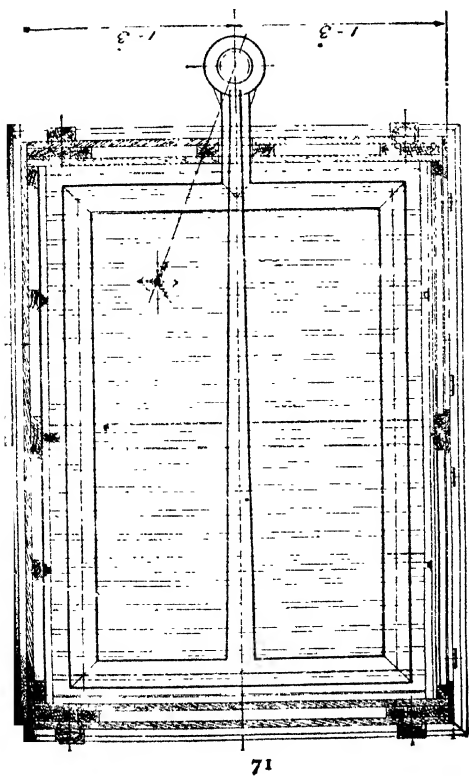


Fig. 50.—Horizontal Section through New Type of Hot-air Incubator.



## INCUBATORS AND CHICKEN REAR

or partly close the ventilators. The best rule is, to have the ventilators a quarter open, gradually increase to full open by the nineteenth day, after which time close them until the chicks are hatched.

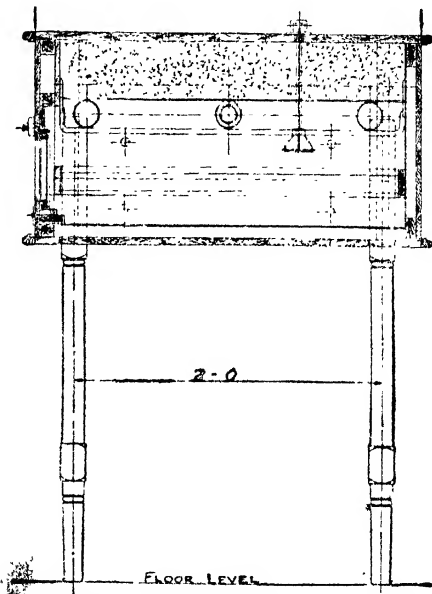


Fig. 51.—Cross Section through New Type of Hot-air Incubator

Nail a 3-in. by  $\frac{3}{4}$ -in. strip across the centre, from front to back, on the bottom, and another each side on bottom and front and back edges. This will allow the board to be tacked all over the bottom.

Procure four pieces of wood 2 in. by 1 in. to be

## HOT-AIR INCUBATOR

for the egg trays.  
 these up true. Nail  
 right-side one in its  
 Put the two venti-  
 holes in the left-side  
 see that the air shaft  
 ar, and fix that in. Between  
 two other centre runners an  
 at, the height of the front, is  
 from 3 in. by  $\frac{3}{4}$  in.; another  
 ade for the back. The space  
 een these two uprights carries a  
 of 3 in. by  $\frac{3}{4}$  in. Fix these five  
 es of wood together by nailing  
 ough the runners into the other  
 es. Place this exactly in the  
 re of the incubator and perfectly  
 ight. The front upright is first  
 ned in with panel pins driven  
 gh the front; the back upright  
 be nailed in from the back.  
 long panel pins may be driven  
 gh the bottom into this centre  
 ure, which holds everything firm.  
 ro uprights can now be fixed to  
 ont at each side to fill in the  
 ce of 6 in. from top to bottom, but

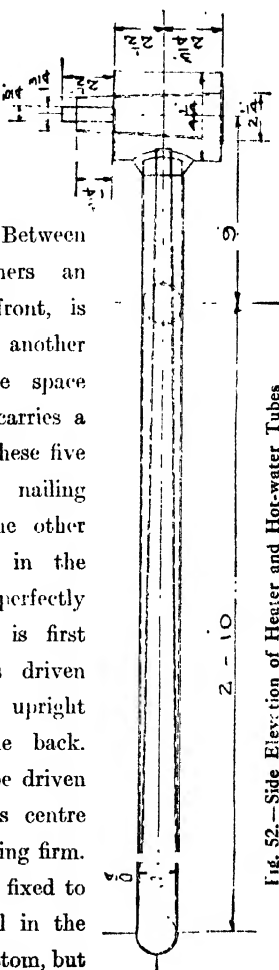


Fig. 52.—Side Elevation of Heater and Hot-water Tubes

## INCUBATORS AND CHICKEN REARI

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not to come flush with the  $\frac{5}{8}$ -in. inner sides. Allow  $\frac{1}{2}$  in. to form a rebate for the glass doors to fit against. Nail a strip all round the inside front, and let  $\frac{1}{2}$  in. over for door rebate. Cover the front with millboard, allowing an air space as in all other parts of the machine. It is this air space, or double casing, that keeps the chamber temperature even. One very thick wall will not do it. The millboard or strawboard acts even better than wood. The double glass doors can be made of strips of wood  $1\frac{1}{4}$  in. by  $1\frac{1}{2}$  in. Lay these down, fasten another smaller frame to them. Nailing with panel pins will make the doors very strong.

The construction of the woodwork has been simplified to assist readers who are not skilled woodworkers; consequently, stump mortice work for the door frames has been avoided.

The two doors must fit the openings left for them. An illustration (*see* Fig. 64) is given of a portion of double glass doors, and this will simplify everything. Lay one glass in its place; fix this in with a strip of wood which forms a rebate to hold the other glass, to be seen with a few tacks and putty. Two  $1\frac{1}{2}$ -in. butt hinges are required for each door. The doors must be fastened securely and easily opened. This is best effected by a spring catch, as shown in Fig. 46. The doors, now fitted, will be best left off until the machine is finished.

The egg drawer or trays (*see* Figs. 66 and 67) will

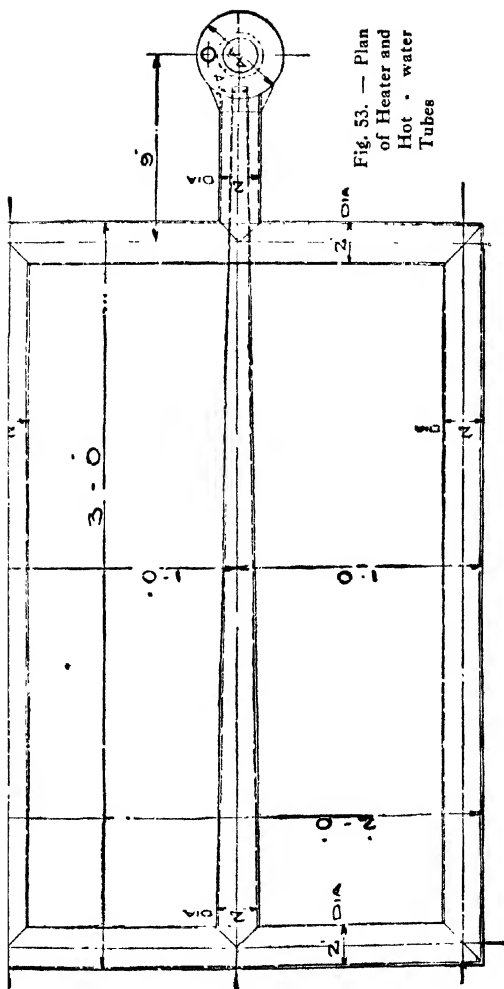
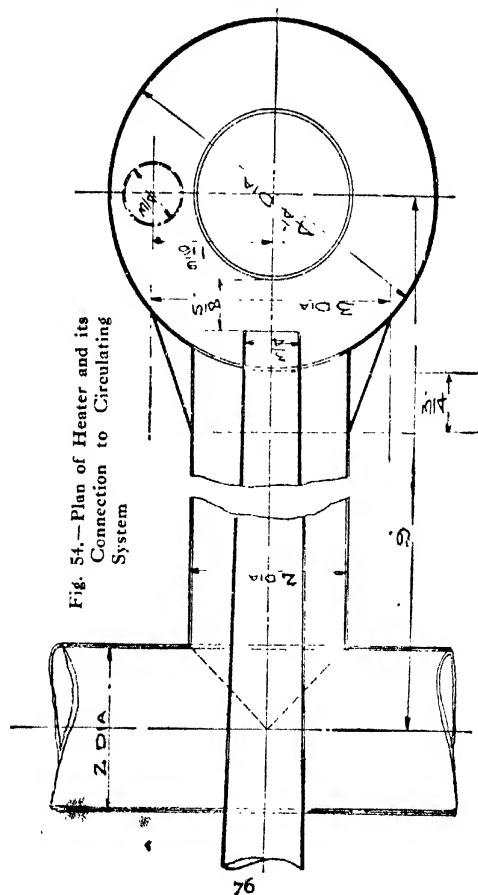


Fig. 53. — Plan  
of Heater and  
Hot - water  
Tubes

## INCUBATORS AND CHICKEN REARE

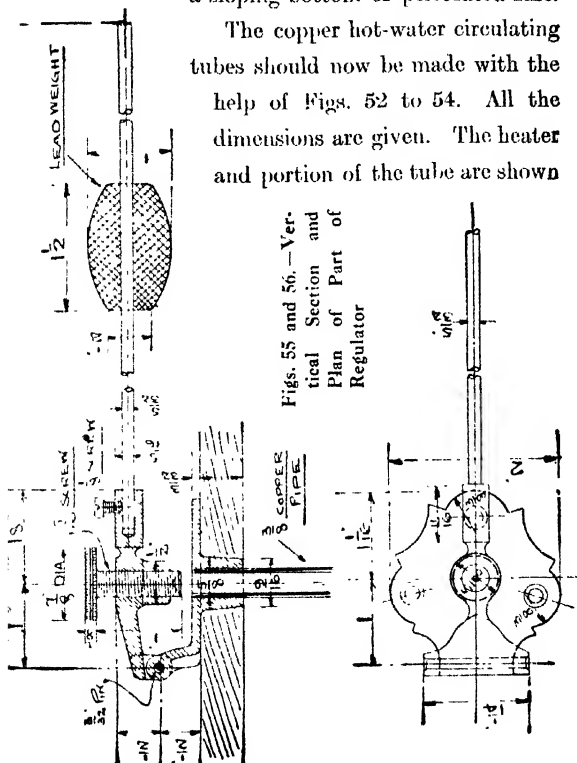
made from 2-in. by  $\frac{1}{2}$ -in. stuff, free from knots. S. nail a frame together of 2 in. by  $\frac{1}{2}$  in. Into this,  $1\frac{1}{4}$  in. apart, fix a  $1\frac{1}{4}$ -in. by  $\frac{3}{8}$ -in. strip, with the top



## HOT-AIR INCUBATOR

ered off. Two panel pins will hold each strip firm. Thin calico is tacked along each side of the egg drawer, at the back and front; this is to sag down or droop, as illustrated in Fig. 67. The eggs will rest firmly on these trays, and can be more easily handled than on a sloping bottom of perforated zinc.

The copper hot-water circulating tubes should now be made with the help of Figs. 52 to 54. All the dimensions are given. The heater and portion of the tube are shown



Figs. 55 and 56.—Vertical Section and Plan of Part of Regulator

## INCUBATORS AND CHICKEN REARE

in Fig. 54 to larger scale; 6-lb. or 7-lb. sheet copper is the most suitable metal. The heater is filled with water by the filling pipe, as shown close to the flue. The heater causes the warmed water to flow through the 2-in. tubes to the left and right of the smaller centre tube. Passing around, it meets again, entering the long central tube where it discharges into the heater, to be again heated and distributed. This system gives a more even temperature to all parts of the egg chamber, which is easily maintained at small cost. The heater should always be kept full of water when in use, and any lost by evaporation must be replaced by adding some warm water.

To fix the circulating tubes, cut an opening 2 in. through the centre of the right-hand side of the incubator down to 7 in. from the inner bottom. The 2-in. tube connecting the heater with the circulating tube will fit in this groove.

Out of  $\frac{3}{4}$ -in. iron rod make two carriers the width of the machine, by flattening and bending up about 4 in. through the flattened part drill two holes for screws, which will hold this carrier in position. The carrier holds the heater tubes 7 in. from the bottom and quite level. It shows where the screws go and the method of fixing them.

Between the outer and inner case, just cut down, a piece of wood can be nailed in to strengthen the side; and inside, at the top, can carry a strip nailed along, to bridge the opening and receive the pins when the top is fixed.

## HOT-AIR INCUBATOR

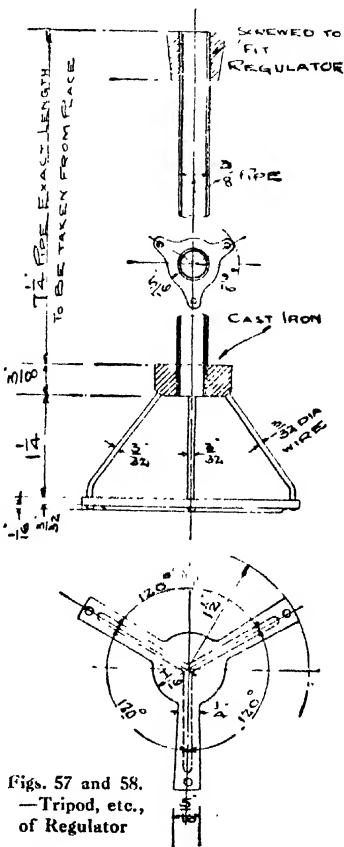
piece of sheet metal is fixed round the top half of tube; and another piece, shaped to the bottom half, and with rose-headed screws to the incubator side.

Adjust the heater equally, and fix with to the carrying rod. Res can be fixed to is screwed into the line. Lay a sheet rawboard all over heating pipes, and up to the top with is.

The lengths of  $\frac{5}{8}$ -in. chwood can now be off to form the top. move the tongue or ve from one piece,

fix this flush with front, and board until the worker is at the length of to carry the regu-

Exact measure- s are given in 47. Through this a hole is placed



Figs. 57 and 58.  
—Tripod, etc.,  
of Regulator



to allow a  $\frac{3}{8}$ -in. copper tube,  $7\frac{1}{4}$  in. long, threaded ends, to pass into the egg chamber. The capsule tripod screws on the end in the egg chamber, a brass regulator on the top at the other end. Refer.

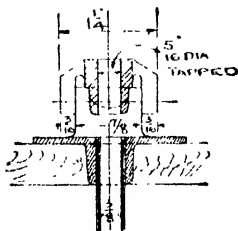
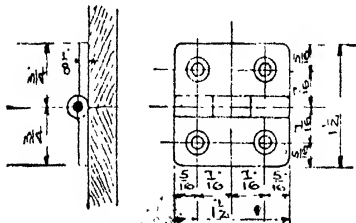
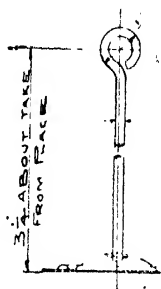
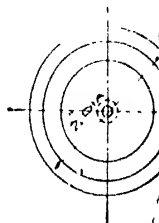


Fig. 59.—Cross Section of Regulator  
Parts at Right Angles to that  
shown in Fig. 55



**Fig. 60.—Butt Hinge**



Figs. 61 and 62  
Damper

Fig. 57 will show how it is fixed with three screws: it is not fixed until the last thing when the damper is over the flue.

The remaining part of the top should now be fixed and the edges of the top and bottom planed true. A head, easily procured at the timber yard, is mitred at

corners to fit round the top and bottom, to be fixed with 2-in. panel pins.

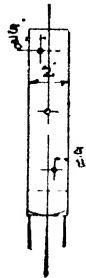
Technical drawing of a mechanical part, likely a shaft or rod. The drawing includes a side view and a detail view of a section.

**Side View Dimensions:**

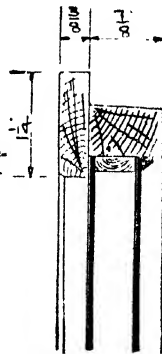
- Total length: 21.0
- Section 1 length: 5.2
- Section 2 length: 5.2
- Section 3 length: 5.2
- Section 4 length: 5.2
- Section 5 length: 1.4

**Detail View Dimensions:**

- Section 1 diameter: 1.2
- Section 2 diameter: 1.4
- Section 3 diameter: 1.6
- Section 4 diameter: 1.8
- Section 5 diameter: 2.0
- Section 6 diameter: 1.2
- Section 7 diameter: 1.4
- Section 8 diameter: 1.6
- Section 9 diameter: 1.8
- Section 10 diameter: 2.0



**Fig. 63.—Two Elevations of One of the Four Legs**



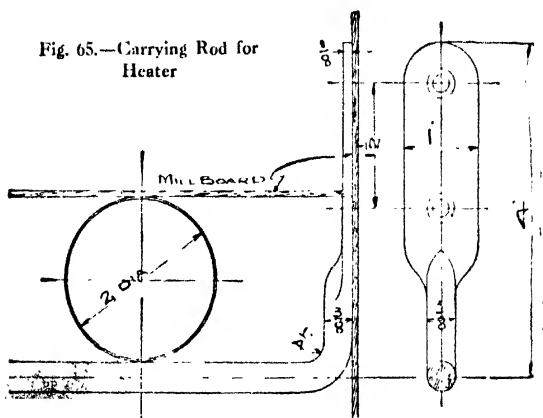
**Fig. 64.—Part Section through Door**

2-in. by 2-in. timber. Figs. 46 and 48 show how the  
 The rose-headed screws fix the leg. Reference to the  
 elevation (Fig. 48) will show the legs fixed and where

## INCUBATORS AND CHICKEN REARER

the stop bead is cut away for the leg to take the weight of the machine.

A lamp rest, as shown in Fig. 46, is made by nailing or screwing a piece of wood to the bottom of the machine, having had the oblong-shaped piece of wood, like the lamp bottom, previously fixed to it. The lamp is



placed on this rest, so that the flame is exactly under the flue.

The lamp is made 7 in. by 4 in. by 2 in., as illustrated. It is fitted with a chimneyless burner, which need not be placed too high into the short flue.

The capsule can now be placed in position, resting in the tripod, and a lifting needle fitted. Let it rest in the button on the top of the capsule, and stand  $\frac{1}{4}$  in. above the

## HOT-AIR INCUBATOR

brass regulator plate. The end on the capsule is blunt; the upper end is pointed to fit into the socket of the regulator screw. Fit a brass rod from the regulator as shown, to reach a little beyond the flue, and construct a damper with hanger as shown in Figs. 61 and 62. A lead weight

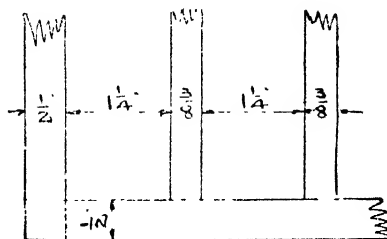


Fig. 66. Plan of Egg Tray without Calico

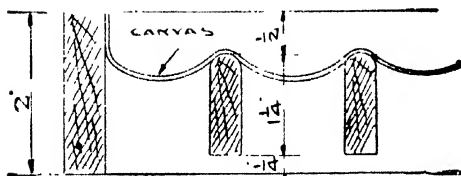


Fig. 67.—Section through Egg Tray

will be required to slide along the regulator rod. Reference to the sectional elevations (Figs. 49 and 55) will give the position of all the various fittings.

With the parts removed for convenience, the machine can be glasspapered smooth, stained, the nail holes puttied up, and the whole polished. An easy stain to make would be oak. Add brunswick or berlin black to turpentine

## INCUBATORS AND CHICKEN REARE.

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until the required strength is obtained. To get mahogany colour add some red. Apply with a brush. This being a spirit stain, it dries rapidly. A small quantity of polish can be made by dissolving 2 oz. of orange shellac in  $\frac{1}{2}$  pt. of methylated spirit. First rub the work over with thin coat of linseed oil, and then apply the polish. When this is hard, screw on the hinged windows, spring catches and the regulator. If wished, make four ornamental corner plates of thin sheet copper or brass, as shown in Figs. 46 and 48, and fix with small brass rose-headed screws. The finished incubator is now ready for use.

This is one of the very few hot-air machines in which the heat is supplied from hot water. With the usual type of hot-air incubators, if the lamp is left untrimmed, forgotten, or by accident the flame goes out, the eggs may be chilled. But in this case, should the lamp go out it would be many hours before the eggs became cold.

Incubators constructed on this principle have been in use by Mr. Hall for years. Actual practice has proved their advantages in the supply of very large quantities of day-old chicks.

## CHAPTER VI

### Heat Regulators

HEAT regulators used in incubators depend for their action upon the universally known fact that matter expands with increase of temperature, and contracts as temperature decreases.

Briefly, if a box made of very thin metal is filled with fluid and sealed, its walls will bulge out or cave in accordingly as the fluid expands or contracts with alterations of temperature. It will be easily understood that by means of a system of delicately poised levers, the bulging of the box may be made to open a damper and allow heat to escape from a flue. This, then, is the principle of the capsule regulator, by far the most generally used one. Next to this comes the J-tube regulator, in which, again, the expansion of a sensitive liquid is utilised; in this case, it forces up a column of mercury, and the movement is transmitted by leverage, as before. Further, there is an all-metal regulator, which, while at first sight open to objection, has given an excellent account of itself in certain well-known hot-air machines. Other regulators depend on the expansion of gas (generally air), but they are frequently of an experimental nature and there is

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no need to consider them in this book. The capsule and the J-tube devices will answer all ordinary requirements. The all-metal regulator is described on p. 133.

The whole action of a simple regulating system is easily understood by referring to Fig. 11, p. 28, which illustrates a customary arrangement of mechanism when employing a capsule regulator. With any rise in temperature after a certain point has been reached, the top of a capsule will raise the rod A contained in tube B, transmit the motion to screw C, which is adjustable in the pivoted piece D, and thus raise a weighted lever E, from the other end of which depends the damper F normally closing the flue G immediately over the lamp H. A  $\frac{1}{16}$ -in. rise of the vertical rod A is so magnified by the leverage that the damper is raised 1 in. The raising of the damper allows part of the hot gases to pass away direct instead of circulating through the flues contained within the tank. As the temperature of the incubator falls, the capsule slightly collapses and lever E falls, in this way replacing the damper. The system is adjusted by turning screw C, thus raising or lowering it, and by moving block J along the rod E, clamping it in position when desired by the set screw K.

### The Capsule Regulator

This is a most reliable regulator if properly made and used; but it will not regulate every incubator without some adaptation to the peculiarities of construction. It

## HEAT REGULATORS

is designed for use in a hydro incubator, for which it is eminently adapted. The amount of expansion which can be allowed in a capsule is but small, otherwise it would rattle and burst; but the expansive power is great, and it has to be kept in check by mechanical pressure. Fig. 68 shows a common device. Inserted through the exact centre of the tank A, as shown, is a length of small tubing,

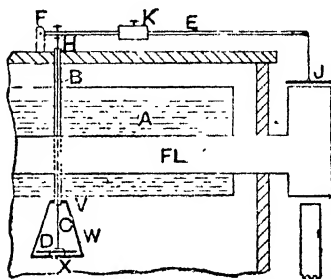


Fig. 68.—Capsule Regulator in Hydro Incubator

through which a rod, c, can freely work; this rod, resting on the capsule d, will rise with its expansion. A lever, e, is placed above the tank, having at one end a fulcrum, f, some distance behind the point where the rod touches, and the other end terminating over the flue with a disk, j, attached to it as a damper. It follows that, immediately the lifting rod c is forced upwards, the lever e will also be raised, and this will be multiplied at the damper end, the increase depending upon the distance between the point of contact of the lifting rod c and the damper disk j,



## INCUBATORS AND CHICKEN REARERS

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and also upon that between the contact point and the fulcrum *F*.

The capsule regulator consists of two thin plates joined together, forming a metal case or receptacle, hermetically sealed, enclosing a small quantity of a volatile fluid, which, by the action of heat, is converted into vapour and occupies a much larger space than the fluid from which it is generated, so distending or bulging out the capsule. On cooling, the vapour becomes liquefied, and the capsule returns to its former condition.

The boiling points of various fluids at ordinary pressure are as follow, the rise of boiling points being in inverse ratio to the elasticity of the vapour of liquid:—

	<i>Centigrade</i>	<i>Fahrenheit</i>
Ether . . . . .	35°	95°
Carbon bisulphide . . .	47°	116°
Alcohol . . . . .	78°	172°
Distilled water . . . .	100°	212°

With these varying boiling points, it is an easy matter to compound a liquid which shall boil at any required temperature, and, the boiling-point being dependent upon pressure, evidently that of any liquid placed within the capsule can be raised by simply sliding weight *K* along the damper lever *E* (Fig. 68). What is required is a liquid which shall boil at somewhere about blood heat (98° F.), and this is found in a mixture of sulphuric ether, and

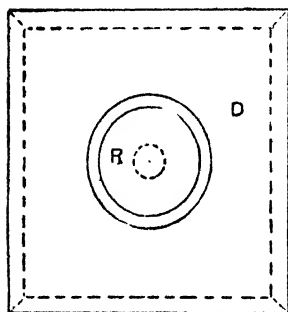
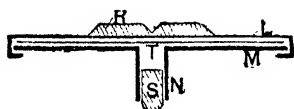
## HEAT REGULATORS

cohol (spirit of wine). [Note : Water and ether will not mix.]

It does not matter, to a certain extent, of what material the capsule is made ; brass is suitable, but the expansibility of the liquid within will be in a measure governed by that of its receptacle. Size and shape also are matters of small moment ; it was usual to make the capsule of square shape, 2 in. each way, but the circular shape is also popular. If the bottom plate is thicker than the top, it will give greater stability to the finished appliance and serve an extra purpose by providing a firm base for a pin, which, affixed to its centre, forms a means whereby it can be kept securely in place in the incubator. The upper plate L (Fig. 69) will require to be  $2\frac{1}{4}$  in. square, of No. 33 gauge, and the lower, M, 2 in. square, of No. 30 gauge B.C. A disk, R, about  $\frac{3}{4}$  in. diameter and as thick as a pin, with a countersunk hole in its centre to form a snug plate for the lifting rod C (Fig. 68) must be soldered centrally upon the upper plate. This disk spreads the pressure over the whole area of the capsule. In the centre of the bottom plate the pin or stud is to be soldered, and it comes in a detail of manufacture which will be found of convenience to those not very expert in soldering. The liquid employed having to boil at about  $98^{\circ}$ , it is almost a matter of impossibility to make a sound joint to the capsule at the same time imprison the necessary liquid. Instead of a solid stud, a small piece of brass tubing, N (Fig. 69)

## INCUBATORS AND CHICKEN REARERS

forms a convenience for filling the capsule; after this has been accomplished, a piece of brass rod, s, is inserted tightly fitting the tube and soldered in; a sound joint can thus be made with the least trouble. Before beginning to make the capsule, the sheets of metal forming it must



Figs. 69 and 70. Section and Plan of Capsule

be made flat by beating with a boxwood mallet so, if the would-be maker is not an expert in this, he will be well advised to purchase the material specially prepared. Having the plate flattened, the tube *N* is placed, and the disk *R* in position, proceed to beat the edge of the large and thinner plate over the bottom of the thicker one, which will allow a turning of  $\frac{1}{8}$  in. all round. Neatly solder this joint with a 2-in. square of blotting-paper, *T*, placed between the plates. Fill the tube *N* with sulphuric ether parts, methylated spirit 1 part; allow the liquid to soak in, adding as required until the blotting-paper will take up no more. Then pour off any surplus, and solder in the plug *s*, which, if carefully done, will make

## HEAT REGULATORS

capsule complete and ready for work. Fig. 69 is a somewhat exaggerated section of a capsule, and Fig. 70 a plan, the dotted lines showing the underside.

Next proceed to fix the capsule in position in the incubator. Taking first the hydro machine (see Fig. 68), the simplest method is to solder centrally through the tank A a length of small brass tubing, B, with the lower end threaded and projecting, say,  $\frac{1}{4}$  in. through the tank bottom; a small brass washer, V, is tapped to fit the tube, and to this is soldered or riveted a couple of straps or bars of brass, W, bent to form a hanger, and joined at the base by a washer or disk of metal, X, having a central hole to accommodate the stud N (Fig. 69) on the base of the capsule, Fig. 71 shows this in detail. The lifting rod C will then pass through the tube B and rest in the counter-tank hole in the disk of the capsule. The depth of this hanger must be regulated by the distance between the tank and the eggs; it should be deep enough to allow the capsule to rest within 2 in. of the tops of the eggs.

The damper, as already explained, needs a lever (see E, Fig. 68). It may be of, say,  $\frac{3}{16}$ -in. brass rod, or of ribbon brass, as shown in Fig. 72, fixed to a crosspiece of the same material, about 1 in. long, at its back end, and having at each end a small countersunk hole centrally punched or filed. About 1 in. (or less) from the cross-piece the lever must be drilled and tapped and fitted with a small adjusting screw. To facilitate this, and also the fixing of it to the

## INCUBATORS AND CHICKEN REARER

cross-piece, the back end of the lever may be flattened by hammering; and if a slot is filed in the cross-piece to accommodate the flattened end, the parts which will be in contact can be tinned and then soldered together by the aid of blowpipe. A bracket, F, to support the lever will be requisite and can be made of stout ribbon brass  $\frac{3}{8}$  in. wide and, say 3 in. long, with the ends bent upward, L-shape. Drill

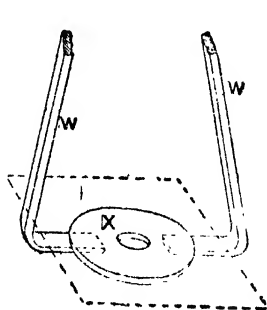


Fig. 71.- Capsule Holder

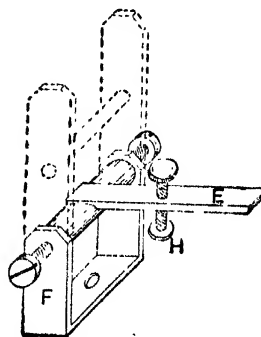


Fig. 72.- Fulcrum of Regulator Lever

hole in its base for fixing, and one in each limb. The limbs are to be tapped and fitted with sharp-pointed steel screws, as shown in Fig. 72. These points, engaging in the holes provided in the cross-piece fixed at the end of the lever, form the fulcrum on which it works. The adjusting screw H needs to have a small disk soldered or riveted to its point, in order to form a sure connection with the capsule through the lifting rod, which can now be

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to length, so that it supports the lever in a horizontal position.

The free end of the lever can be filed into a hook which a light rod or chain will support the upper-plate J (Fig. 68); a weight, K, preferably with a screw, slides freely along the lever.

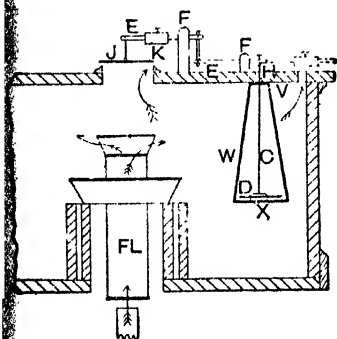


Fig. 73.—Capsule Regulator in Centrally-heated Hot-air Incubator



Fig. 74.—Brass Rod

In an old method of adapting the capsule to a hot-air machine (as shown in Fig. 73), the hanging bracket must be 4 in. long. The upper disk V, instead of being bored and tapped as in Fig. 68, will require to have a hole bored centrally for the lifting rod C to pass through, and three small screw holes by which to fasten it to the top of the incubator. As will be seen by reference to Fig. 73, there are two levers, E E, at different levels, supported on two brackets, F F, the levers being connected

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by a strap of ribbon brass  $\frac{1}{8}$  in. wide. The ends of lever if of rod brass, are slotted, as shown in Fig. 74, and fitted with pins, which also pass through the ends of the brass connecting strap. In this the adjusting screw—the point of contact—lies on the side of the fulcrum opposite that of Fig. 68. This lever can be lengthened to accommodate the sliding weight, as shown by dotted lines, the weight  $\kappa$  can be mounted upon the upper lever, as shown in full lines. The bracket for the upper lever will

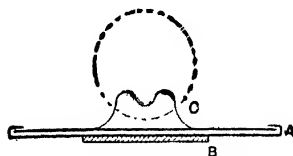


Fig. 75.—Modified Capsule

need to be somewhat taller than that for the lower, shown by dotted lines in Fig. 72, which it is drawn straight by a cross-bar to prevent the limbs being forced apart by the screwing-up of the fulcrum screws.

The above are substantially the arrangements commonly in use when the capsule regulator is employed, but the hingeing and adjustment of the damper lever is frequently accomplished in other ways; see, for example, Figs. 24, 25, 26, 27, and 28.

**A Modified Capsule.**—Fig. 75 shows a capsule of sheet brass, both sides being of the same thickness. A leather disk, B, is glued on the bottom, and on the top is soldered one of the copper disks, C, found in shot cartridges; this has two holes in it. Before soldering the top an

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com together, make a small hole in one corner, and pass a thread through the holes in the copper disk. The capsule is filled by holding the corner having the hole in the spirit and pulling the thread in and out. Sufficient spirit is sucked in by this means, and the hole is stopped instantaneously with a drop of solder.

**The "Acme" Regulator.**—In a later chapter describing a number of the incubators on the market will be found illustrations of two or three special regulator arrangements ;

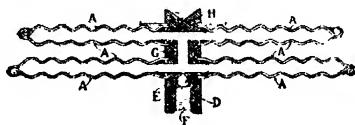


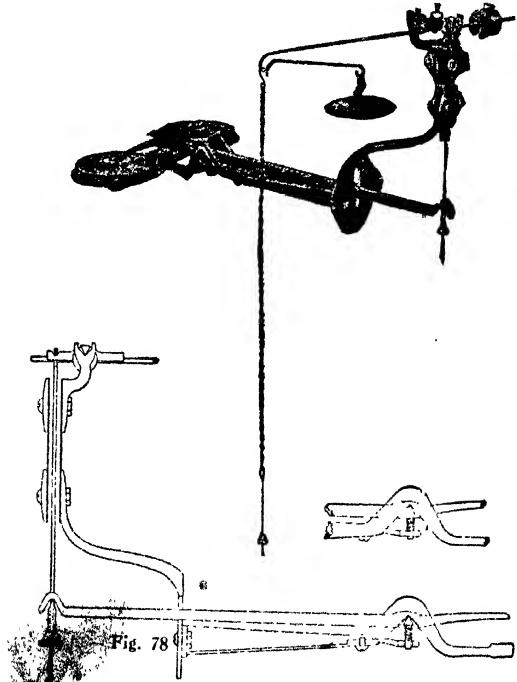
Fig. 76. —"Acme" Capsule

It is space must be found here for particulars of the Acme capsule ("compound wafer thermostat") used in the "Peerless" incubator made by the H. M. Sheer Company, Quincy, Illinois, U.S.A. It consists (see Fig. 76) of four corrugated disks, A, of a bronze-like alloy so joined together that they form two chambers for the volatile fluid, upon the expansion and contraction of which the working depends. The cup-shank H, the hollow stem G, and the valve stem or valve shank D are riveted and soldered in position, and through the stem there is inserted into the chambers a measured quantity of the volatile fluid. Then, at the position illustrated, the capsule is placed in a warm



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bath ; the fluid does not escape through the opening because its density is so much less than that of water. As the liquid converts part of the fluid to gas, any air is forced out through the opening.



Figs. 77 and 78.—“Acme” Tandem Regulating System

the opening, and when this process is complete the valve *F* automatically closes the opening ; afterwards, the insertion of the screwed plug *F* ensures the permanency of the seal.

## HEAT REGULATORS

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any patterns of Peerless incubators, this capsule is in tandem fashion, as illustrated in Figs. 77 and 78. In this arrangement, every lever has for fulcrum a knife-edge, and thus, by reducing friction to a minimum, the capsule is made as sensitive as possible.

**The J-tube Regulator.**—This is far more sensitive than any other regulator in use, but it has its disadvantages. It is to be so poised that the weight of a pin will shut or open it; and should the bearings get clogged, the damper will force the mercury in the tube beyond the cork, and not lift the damper. It is quite inexpensive, and can easily be constructed. A glass tube A (see Fig. 79), measuring 7 in. by  $\frac{1}{2}$  in., and sealed at one end, is turned and so as to form the letter J. The sealed end should be turned up about 2 in. Ether, being a spirit, which at about 95° F., is the best agent to move the mercury, it should be poured into the tube until it occupies one-third of the sealed end. Now pour in mercury until it rises within about  $1\frac{1}{2}$  in. of the open end of the tube. The ether will now be found to have left the sealed end of the tube. To get the ether back into position, place the finger on the open end, turn the tube upside down, and incline the tube so that the ether returns to the sealed end where it must always remain. A piece of cork B, which must fit the glass tube quite loosely, is fastened to the end of a piece of No. 18 wire, C, about 4 in. long. The cork is now passed into the tube and allowed to rest

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on the mercury, the wire standing 2 in. above the  
This tube is placed perfectly upright in a wooden  
(indicated by dotted lines in the illustration), with  
top, on the side of the incubator as close down to  
eggs as the drawing in and out of the drawer will pe.  
If convenient, the wooden case should be fixed in  
centre of the incubator, from which point most hea

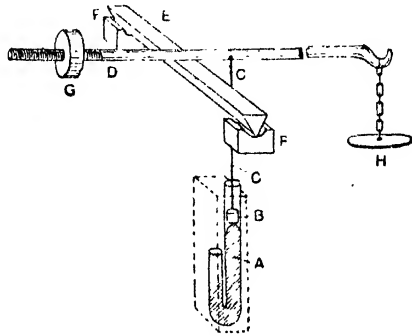


Fig. 79. J-tube Regulator

derived, especially if the incubator is made with ~~single~~  
instead of double walls. The damper rod **D** is balance  
on a V-shaped piece of iron or steel **E**, the sharp end  
of the V resting on two pieces of concave agate stone  
(procured from weighing-machine makers). These stones  
are let into the incubator top, and secured with a glutin  
substance (seccotine, marine glue, etc., would answer.  
The damper rod **D** consists of a piece of  $\frac{1}{4}$ -in. round  
iron wire; a stair rod would be suitable. A thread

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or  $\frac{1}{4}$  in. long is cut on one end of the damper rod, a lead weight *G* screwed on to balance the damper *H*, which covers the lamp chimney. The V-shaped ring is soldered to the rod and at right angles with the rod must cross the centre of the bearing. A centre-punch mark is made in the damper rod for a point of the regulating rod *c* to rest in. The centre-punch mark must be  $\frac{1}{2}$  in. from the fulcrum, so that when the mercury rises even  $\frac{1}{16}$  in., the damper cap on the end of the rod will be lifted more than half an inch; but unless this damper rod is balanced by the screw weight, it will fail to lift the cap, and the mercury will rise over the cork, by the expansion of the ether in the sealed end of the tube, at a heat of  $104^{\circ}$  F.

**Automatic Gas Regulator.**—Most of the automatic regulators for incubator work now on the market are patented articles, but the arrangement shown by Fig. 80 may freely be made by anybody. Assume the presence of a capsule system with the usual damper rod *s* (Fig. 80). At the back of the rod, behind the pivot, drill a hole to take the rod *R*,  $\frac{1}{8}$  in. or more thick, and 6 in. or 8 in. long (*see also* Fig. 81), which should be strongly soldered in place. On its extreme end, solder at right angles a pin and a corresponding pin on the end of the lever of a gas cock. Connecting the pins must be a brass strap *c*. Solder the whole elbow to a small brass base or foot similar to *F* (Fig. 81). The two pins should be lightly riveted

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over to secure c from slipping off while allowing a free turning movement. When the correct positions have been found, screw the elbow in place by its foot, and connect up the flexible pipes shown in Fig. 80 to the inlet and outlet ends, leading the latter to the burner. As the capsule expands and lifts the damper arms, it depresses R and turns round the cock lowering the gas. A reverse



Fig. 80. Automatic Gas Regulator

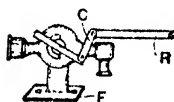


Fig. 81. Gas Cock

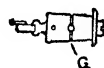


Fig. 82.—Plug of Gas Cock

movement turns up the gas. It is necessary to find by experiment the exact cut-off position of the cock before making the connection strap c, and to arrange it in such a way that the slightest movement lowers the gas. To prevent the gas being turned entirely out, fit a tiny V-shaped groove G (Fig. 82) all round the plug in line with the bore hole; this will always allow some gas to pass.

As some readers may prefer a valve regulator to the arrangement above described, one is here shown (see

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Fig. 83). The body B may be a short length of  $1\frac{1}{4}$ -in. tubing, in which is soldered gastight a partition, P, leaving a seating bored to fit the valve shown, which is soldered in one with its spindle, v.s. A bottom is soldered to the body, to which is secured centrally a short tube only fitting the spindle, and having a short weak spiral spring, s, underneath the spindle. In the cover is arranged a small, internally threaded stuffing box, to which the

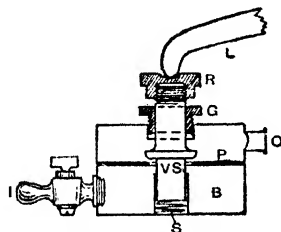


Fig. 83.- Valve Regulator for Use with Gas

and G is fitted. Tallow or other suitable packing keeps the spindle gastight, while allowing free vertical movement. A lever, L, fitted to the back of an ordinary capsule regulator arm, on the principle explained in the preceding paragraph, is bent to bear on the adjustable cap, R, which may be screwed up or down to a suitable height. The valve may be normally open  $\frac{1}{16}$  in. or less, and when the gas expands through overheating, the lever L is forced down and shuts the valve. On the lever rising again, the spring s pushes the valve open. The valve may be about  $\frac{1}{2}$  in. in diameter, and may have one or more small V-

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notches carefully filed in its beat to allow some lit gas to pass when the valve is shut, thus preventing the light going entirely out. An inlet cock *i* and an outlet *o* are shown, to which rubber pipes are to be attached. Two or three lugs may be formed in one with the bottom plate to project beyond the body, each drilled to take a wood screw, and used to secure the whole in its correct position.

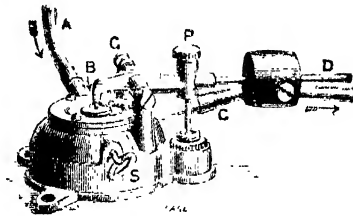


Fig. 84.- Excelsior Gas Valve

The Excelsior gas valve, obtainable for about seven shillings, has points of similarity with the above. By its use the ordinary damper arrangement is obviated. The damper lever *D* (see Fig. 84) is continued to *B*, where it operates the valve. *A* is the gas inlet, and *C* the outlet. *G* is the pivot, *P* the adjustment screw, and *S* the by-pass control.

It is not essential to provide a regulator or controller when gas is the source of heat, any more than it is when an oil lamp is used; but if, of course, means of saving gas when the internal temperature of the machine rises

## HEAT REGULATORS

adopted, it conduces to economy in working. When fittings are ordered with the Hearson incubator, the arrangement shown in Fig. 85 is supplied, and this works satisfactorily where the gas pressure remains very even. In many places, however, the pressure varies; in thousands of houses, for example, the meter is too small to serve all the lights, and when a capacity is exceeded the burning on or off of gas at any one fitting may cause the other lights to go out or jump. Calling a larger

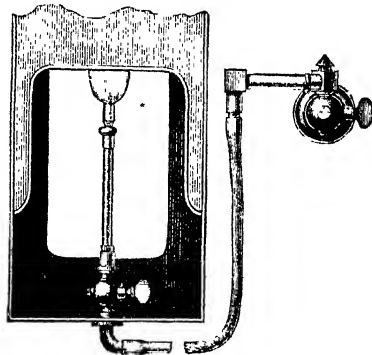


Fig. 85. Hearson's Gas Attachment without Governor

meter, it is advisable in all such cases to employ a governor on the incubator fitting which automatically prevents a sudden access of surplus gas when the house lights are turned down. Fig. 86 shows the Hearson governor, and by means of this device the supply may be adjusted to a nicety, and the flame remains constant in size.

**Regulating Incubator Heated from Separate Hot-Water Apparatus.**—It is practicable to supply an incubator



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from a separate hot-water apparatus, but the regu must be worked on a ventilating shaft. The mecha is precisely the same as that used to control the obtained from a side lamp. The damper works over top of the shaft, and when raised by the capsule al heat to escape. By forming the shaft as shown in Fig

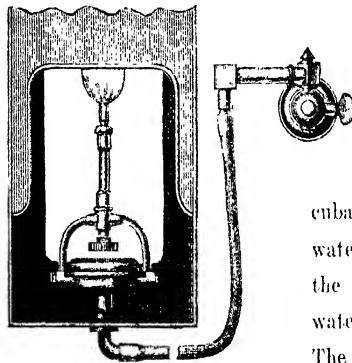


Fig. 86. Hearson's Gas Attachment with Governor

direct draught avoided. A tap may be inserted in flow-pipe between the

incubator and the hot water apparatus, so that the quantity of hot water may be regulated. The water in the tank should be at 110°

The heat of the water

in the supply apparatus depends on the distance it has to travel before it enters the incubator tank, and unless the flow-pipe is insulated by covering with slag wool, hair felt, brown paper, etc., it will lose much heat.

**Electric Alarm for Incubator.**—Electricity has not been applied in any serious way to the solving of incubator problems. Electrical regulators, for example, are by

## HEAT REGULATORS

means out of the question, but it is doubtful whether it would have any real advantage over the present mechanical arrangements. On the other hand, indicators and alarms may be advantageously worked by electrical means as it is a simple matter to cause the indication

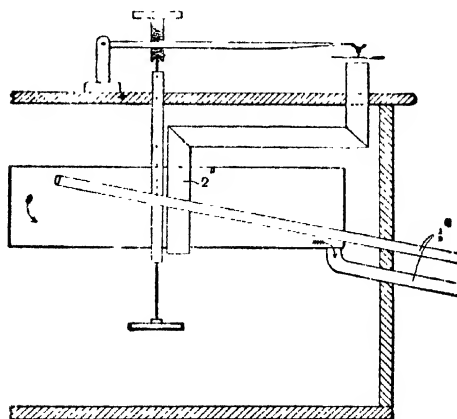


Fig. 87. Regulating Incubator Heated from Outside Source

high or low temperature to be given in a place far removed from the incubator house.

The most effective electric alarm to indicate high or low temperatures is the gardener's greenhouse electric thermometer, which is made and sold by all manufacturing electricians. It is similar to an ordinary mercurial thermometer, but it has in its tube two platinum wires, which are connected to two terminals in circuit with an electric

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bell. The tips of these wires can be moved in the tub and adjusted to any temperature. Should the mercury rise too high or sink too low, the electric bell rings. Having two bells of different tones, one on the high and one on the low temperature circuit, the owner can know at once what the trouble is. Another effective alarm may be made with an adaptation of a fire alarm, as shown in Fig. 88. Procure two very thin strips of copper and zinc, of equal thickness, from  $\frac{1}{4}$  in. to  $\frac{1}{2}$  in. wide, and

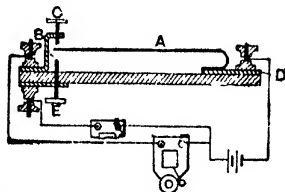


Fig. 88.-- Electric Alarm for Incubator

from 3 in. to 4 in. long (A). Coat one side of the copper and one side of the zinc with solder, and sweat them together, that is, heat them in a Bunsen burner or over a hot iron until the solder flows; then drill three or four small holes at nearly equal distances apart through the strips, and rivet them with brass rivets. Bend one end as shown, and solder this to a strip of brass, D,  $\frac{3}{4}$  in. wide, 1 in. long, and  $\frac{1}{8}$  in. thick. Fix this with short brass screws to one end of an ebonite block 1 in. wide,  $\frac{3}{4}$  in. thick, and 4 in. or 5 in. long. To the other end of the block fix a brass bracket, B, carrying an adjusting screw

## HEAT REGULATORS

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On the opposite side fix another piece of brass, with similar adjusting screw, E, passing through the ebonite block. The tips of these screws will come in contact with the tip of the strip A, and connect one of the bell circuits. When the temperature is too high, the zinc will expand fastest, and bend the strip until it comes in contact with one of the screws. When the temperature falls, the zinc will contract, and bend the strip in the other direction. Adjusting the screws to the highest or lowest allowable temperature by the aid of a thermometer, the strip should be midway between the two when the temperature is 103° F. The connections of the alarm with battery and bell are shown in the illustration.

## CHAPTER VII

### Successful Incubator Management

THERE are many incubators on the market. Some supply heat from a tank, filled with water, above the egg chamber; the other kinds give heat from hot air. Opinion is often divided as to which is the better type of machine. In Great Britain the tank machine is used most, but in America the hot-air type is usually employed. For private use or small establishments, the tank is of most service; but for very extensive breeding farms, the largest size hot-air incubators are considered essential.

In selecting a machine, have the best that can be afforded, and, if it is bought complete, see that it bears a trade mark. The manufacturer who has protected his wares has both his capital and reputation at stake. Any of the machines described in earlier chapters may be regarded as thoroughly reliable.

A really reliable incubator requires very little attention. Simply trim the wick, fill the container with water, and turn the eggs over twice a day; the whole routine should not occupy more than twenty minutes. The work and management of a machine is simplicity itself. The best sizes to use are the 50- and the 100-egg sizes.

## INCUBATOR MANAGEMENT

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near). The smaller ones are with difficulty maintained at a regular temperature, and cost more in proportion to size. Much larger machines are best adapted to the very extensive breeding establishments.

For successful hatches, the eggs should be as near possible of the same age. For this reason alone only large breeders can fill up even one incubator of 800-egg capacity in the most satisfactory way.

**Position.**—Place the incubator where it is to be worked; room facing north or free from the sun's rays. A cellar or other cool place free from draught is best; never an outhouse, where there are great variations of temperature, so that it stands level and is firm.

**Filling Tank.**—Fill the tank with very hot water by filling tube on top of the machine.

**The Lamp.**—Fill the lamp with oil. If a "Silver" chimneyless burner, cut the wick straight across (not V shaped), and allow it to burn a few minutes to obtain good flame. When burning and trimmed correctly, place it under the flue.

**Regulator.** Put the capsule in its place in the centre of the hanger, and slide the lifting needle down the centre on top of the machine, so that it rests on the button in the centre of the capsule. The upper end is placed in the socket of the regulating screw. Place the weight as far as it will go to the left. Turn the regulating screw,

## INCUBATORS AND CHICKEN REARERS

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and see that it works freely, the damper hanging direct over the chimney where the lamp is burning.

**Moisture.**—Put the canvas in the water tray, and the eggs are not new laid, half fill with warm water, and place it in the centre of the egg chamber. The aperture in the zinc tray bottom should rest over the hole in the floor. If the eggs are new laid, put no water for about the first fourteen days. See that the water is replenished when required and the canvas kept clean. Next spread the canvas in the egg drawer.

**Thermometer.**—Put the thermometer in its position in the egg drawer front, and always keep it there. It should be drawn out far enough to see the thread of mercury when reading the temperature.

**Initial Regulation.**—With the egg drawer in, leave the machine. In some ten hours, according to the weather and season, the incubator can be regulated by moving the screw and weight, so that the thermometer registers the temperature at which it is proposed to work; 103° with the thermometer not quite touching the eggs, will give the best results. When the adjustment has been completed, the heat in the egg drawer will remain constant. Regulated properly, the damper should be lifted off the chimney at 102°. Endeavour that the heat in the egg chamber never exceeds 104°.

**Eggs.**—Eggs marked with an X on one side and on the other are placed on the canvas in the egg drawer.

## INCUBATOR MANAGEMENT

turned over twice daily. It is better to fill the drawer eggs than merely to half fill it.

**Cooling.**—The eggs must be cooled when turning. Experience will soon enable this to be done. In the first week the operation of cooling is enough, by the time it takes to turn the eggs. Allow a little longer next week, and increase the time until the eggs hatch. As a guide, first week five minutes, second week ten minutes, third week fifteen minutes. See that the heat ( $103^{\circ}$ ) the egg chamber returns in an hour, not in twenty minutes one day, and at another time, in two hours; each time the eggs are turned have the heat back in an hour. This will produce, invariably, splendid chicks.

**Variation of Temperature.**—A little variation of temperature, above or below that fixed on, will not affect general results; but if a rise or fall lasts more than a few days the weight should be moved to correct it. When the egg drawer is taken out, the damper should automatically close on the chimney in a few minutes. The regulating weight should on no account be turned when the egg drawer is in its place and with the heat at  $103^{\circ}$ , or the regulating power of the swollen capsule may be impaired. Always open the drawer a little before altering the regulator, and so when turning the eggs. To make great alterations in the temperature, move the regulating screw. For all adjustments, slide the weight towards the lamp.



## INCUBATORS AND CHICKEN REARE

The weight should not be more than halfway across rod. Remember that the nearer the weight to the the more sensitive the capsule.

**Evaporation.**—Evaporation of water in the tank not very great; but see that the tank is kept full,

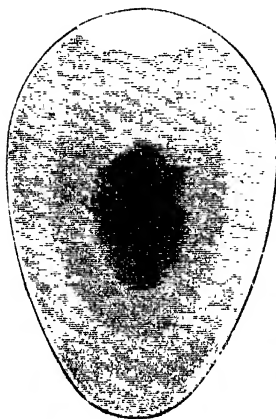


Fig. 89.—Fertile Egg after 7 days

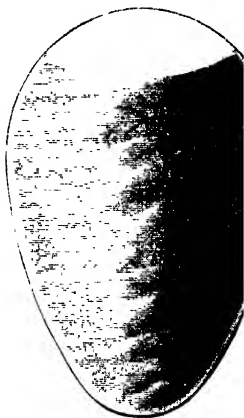


Fig. 90.—Fertile Egg after 13 Days

difficulty will be experienced in maintaining the temperature of the egg chamber.

**Examining Eggs.**—In a week the eggs should be examined before a light. Those that look dark are fertile and should be put back in the egg drawer. The ones that are clear and look like new-laid eggs are not fertile and should be removed. The appearance of a fertile egg after a week is indicated in Fig. 89; after thirteen

## INCUBATOR MANAGEMENT

in Fig. 90; and at twenty days, in Fig. 91; an egg—a fertile egg in which the germ has died—in

**Periods of Incubation.**—The periods of incubation are . . . eggs 42 days, swan eggs 42 days, goose eggs 30 days,

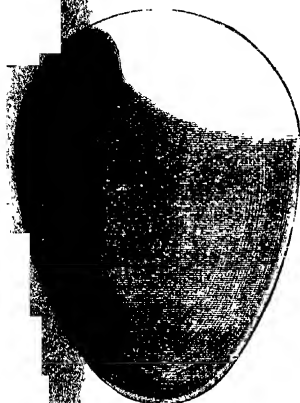


Fig. 91.—Fertile Egg at  
20 days

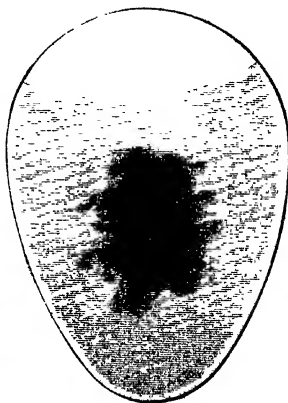


Fig. 92.—Addled Egg

eggs 28 days, duck eggs 28 days, pheasant eggs  
eggs, hen and bantam eggs 21 days.

**Setting Eggs, etc.**—The eggs should be put carefully  
and kept in this position; they are then more  
turned over. The average-size egg will give best  
results. Many eggs go into incubators with a fracture,  
small that it can hardly be seen before a good light;  
the eggs as they are being introduced into the drawer

## INCUBATORS AND CHICKEN REARE

are given a very gentle tap together, a cracked one is instantly detected by the sound. Of course, it is discarded, although with valuable eggs the fracture should be covered over with a small strip of court plaster; if handled carefully they usually hatch. The eggs should be marked on both sides to ensure their being turned over.

No of incubator	.....
Vendor of eggs	.....
No eggs set	.....
Date	.....
due to hatch	.....
Clears	.....
Broken yolks	.....
Added	.....
Dead in shell	.....
Date for water	.....
Chicks hatched	.....
Remarks	.....

Fig. 93. Card in Holder  
for Keeping Record

A holder having a hole in the top by which to suspend is made to carry some dozen papers. A useful size would be 4½ in. by 3 in., the size of a tradesman's business card. The papers should be written or printed as in Fig. 93. The papers should be written or printed as in Fig. 93.

Whatever now is required can readily be had. Take the tablet off the machine, and enter against the heading what has been done. For instance, if the

A good device is the one side and an X on the other. With large quantities of eggs incubated, it may be ascertained when they are due by adding twenty-one days to the date shown on the eggshell.

### How to Keep Records.

hatching results should be kept with ease and accuracy. The method described is brief, simple and correct. Each incubator should be numbered. A

## INCUBATOR MANAGEMENT

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examined and five discarded as clears (unfertilized), write in the column for clears. When the hatch is over for future reference place this paper fully totalled in the tablet holder behind the others. For each use a fresh paper.

**Turning the Eggs.** Do not turn eggs for the first four hours after they have been put in the machine, as they are cold eggs when inserted. Some move outside eggs to the centre and vice versa. This is because if the machine varies much in different parts of the egg drawer, many of the eggs undoubtedly will be spoiled. Therefore they are better left in the same place, for then only the outside eggs would suffer. As the eggs are clears, addled, broken yolks, and dead in shell are removed, so the outside eggs become more towards the centre without this changing process. The eggs should be turned night and morning by rolling them over. A slight and a slight push with the finger, and always towards the centre of the drawer, will cause them to turn without shaking them. But if they are revolved towards the sides to move them over, the outer eggs have to touch and so are shaken.

It is necessary to turn the eggs to prevent the life germs coming to the membrane next the shell. But this turning should be done after cooling instead of before, as is often done.

The lower part of an egg under a hen, or in the incubator, is much colder than its upper surface. The

## INCUBATORS AND CHICKEN REARING

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germ always rises to the top whichever way the egg is moved. Now, by this life germ coming into contact with the cold part of the egg, and, besides, having to remain to be "cooled" or "aired," it is in the first stages of its development unable to withstand this treatment, and so dies. The hen leaves her nest to feed, etc.; this allows the eggs to cool gradually. When she returns and "shuffles" or moves them, those she does turn do not suffer by their germs rising to the upper and cold surface, because the hen is on them and soon supplies the necessary heat. This is a most important point in incubator management.

**Cooling the Eggs.**—For the purpose of cooling the eggs, open the drawer as wide as possible, and turning the eggs by rolling them over towards the cake. As soon as a few rows are turned, close the drawer in much. Continue the turning, and as more rows are turned close in the drawer, until all the eggs have been turned. With large incubators this operation has to be done quickly, and the time taken in turning the eggs morning and night cools them sufficiently. The next week all a little longer; the last week from five to fifteen minutes will be required. The season and weather are great factors to be considered. But here is the proof that will also denote if cooling has been managed properly; see that the temperature ( $103^{\circ}$ ) is back again in an hour. If this temperature returns in, say, twenty minutes, it means the egg

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not cooled enough ; or if the temperature is not present for hours, it proves that the eggs were cooled too much. Perhaps the greatest error is working the incubator high a temperature, especially during the last three days of incubation. In such a case the chicks are not full of energy, and do not eat well or thrive. They easily become subject to any disorder or disease.

The best temperature in the egg chamber is 103° with the bulb of the thermometer not quite touching the eggs. The normal temperature of a fertile egg is about 101°.

A beginner with incubators is often alarmed to find on the twentieth morning the heat of the egg drawer up to 106°, and the opened drawer reveals quite a number of live chicks, this is natural. With good fertile eggs they often hatch on the twentieth day, either in the drawer or in the machine. The extra heat is from the live chicks. Some are prone to leave the drawer out all day on this account ; this is wrong. Remove the live chicks, and the surplus heat departs. It is now important to maintain the temperature, and many good hatches are lost by not being able to get the heat up again after taking out a lot of live chicks.

It should be remembered that at the beginning of a hatch all the heat comes from the tank ; but as the live chicks hatch in the egg develops, so heat is introduced into the incubator, and by taking out live chicks, time must be allowed for the water in the tank hotter.

## INCUBATORS AND CHICKEN REAR

**Moisture for the Eggs.**—This is one of the important items in incubator management. A competent person is able to tell by the air space what moisture is wanted and when required. It is very simple. Hold a new-laid egg before an egg-tester, shield with the hands, which is better acknowledged. It will be noticed that the size of the air cell in the egg is only about the size of a threepenny piece; in four days the air cell has grown to the size of a shilling; in ten days to as large as a shilling. The more stale the egg, the larger the air cell is due to the fact that the egg-shell is porous, and evaporation is continually going on. Sometimes the air cell is at the small end of the egg, or at the side; but usually it is at the large end. Here, then, is the vital point regards the air cell and hatching. With new-laid eggs, told by the small air cell, put no water for, say, fifteen days. With staler eggs, those with the larger air cell, place water in the moisture tray at the beginning. By the means on the nineteenth day the air cells in new-laid and the staler eggs become about the same size, and allow room for the living chick to break its way through the egg shell.

On the nineteenth day it is an excellent plan to have a piece of flannel, cut a trifle larger than the egg drawn wrung out in very hot water, laid rapidly over all the eggs, and the drawer closed for ten minutes. This

## INCUBATOR MANAGEMENT

ed, if necessary, on the twentieth and twenty-first if the chicks seem to be in difficulty, coming out of the shells through dryness. Lay this quite hot and flannel over the eggs, and close the drawer for a few days. Open, and remove the flannel quickly, and close again.

Incubators allow more moisture than others. Incubators of one-hundred egg size, four  $\frac{1}{2}$ -in. ventilating holes, in the front,  $\frac{3}{4}$  in. below the tank, will give the best results. With the non-moisture or hot-air machines, open the drawers, quarter open at first, and gradually have them fully open by the nineteenth day, after which time close them until the chicks are hatched.

**How to Examine the Eggs.**—For examining the eggs, hold the egg, large end up, with the points of the fingers of the thumb of the left hand before a lamp or candle. With the right hand partly closed hold it over the top of the egg. This will practically surround it, leaving the back of the egg uncovered, for the light to shine through. The yolk is shown up quite vivid, and in a fertile egg, the embryo can be distinguished on the fourth day, looking in the shape of blood, like a spider in its web. The clear or infertile eggs should be discarded. This method is better than using an egg-testing lamp, many forms of which are to be found illustrated in dealers' catalogues. The eggs are examined with greater rapidity, they do not come in contact with anything cold, and there is a lighted room to work in.



## INCUBATORS AND CHICKEN REARERS

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**The Drying Box.**—This feature of an incubator is useful if properly understood. In the egg chamber there is a moist heat; in the drying box it is dry heat. Chicks should not be left too long in this dry air, or they become excessively thirsty.

**How to Manage the Lamp.**—The management of an incubator lamp is one of the most important factors in the ultimate success of the machine. The lamp should produce a clear light without smoke or unpleasant smell. Thus it is necessary to have a good, clean burner, best oil, and proper wick. The latter collects from the oil dirt and foreign matter, which make it swollen, hard to wind up and down the wick tube, and the oil is prevented from being freely drawn to the burner.

A new wick should be used every two or three hatches. It is sold prepared and in lengths ready cut. The lamp should be trimmed morning and night. A lamp filled with oil gives much more heat; it need not be turned up so high as the half-empty one, and it is safer to use

Always allow a lamp to burn a little, to see that it is all right. Then before inserting it in the machine lower the flame a trifle; the flue draws the flame a little higher. A lamp turned up high does not smoke when on the table, but it will when put under the flue. More heat is procured from a good, moderate light than a dangerously high flame.



## CHAPTER VIII

### Various Incubators Described

In this chapter will be described some leading incubators which, while very far from exhausting the list of commercial machines, will yet be found typical of incubator construction at the present time. They are classified as (1) hydro or hot-water machines, (2) hot-air machines, and (3) combined hydro and hot-air machines. One incubator, in particular, claims to come under the third classification, although, in one sense, all hydro machines can be said to be in that class, as their working depends on both hot water and hot air. Speaking in general terms, the hydro incubator—substantially on the Hearson model—is typical of British machines, and the hot-air incubator—on the “Cyphers” and “Prairie State” models—of the American machines. Of recent years, however, some notable British hot-air machines have been introduced, at least one of them being purely a British production. It will be noted that the leading American makers have agents in England.

### Hydro Incubators

**Hearson's “Champion”** (Spratt's Patent, Ltd., 24 and 25 Fenchurch Street, London, E.C.).—There is no need to

## INCUBATORS AND CHICKEN REARERS

describe this well-known machine fully in this chapter. The hydro incubators described in complete detail in Chapters II. and III. are of the Hearson type, and it must always be remembered that the greater number of hydro machines owe their design to the original Hearson.

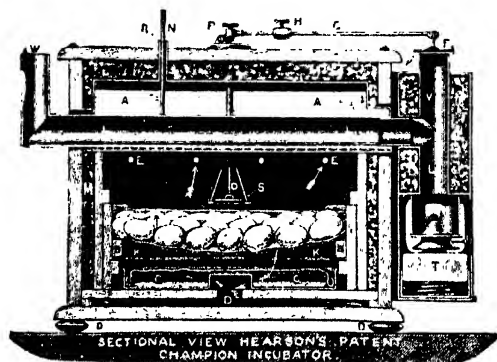


Fig. 94. -Section through Hearson's "Champion" Incubator

It was Charles E. Hearson's invention of the capsule regulator which made possible uniformly successful results with artificial incubation, and on the expiration of the chief Hearson patent in 1895, his design was universally taken up. On the cover of this book is illustrated the Hearson machine. It is made in the following sizes:— 25-egg, 50- to 60-egg, 100- to 120-egg, and 240-egg. There are special sizes for ostrich eggs, etc.

The section of the Hearson "Champion" machine (Fig.

## VARIOUS INCUBATORS DESCRIBED

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94) will be familiar to readers of earlier chapters:—A is the water tank; B, moveable egg tray; C, water tray; D, holes for fresh air; E, ventilating holes; F, damper; G, lever; H, lead weight; K, wooden slips; L, lamp chimney and flue pipe; M, non-conducting material; N, tank

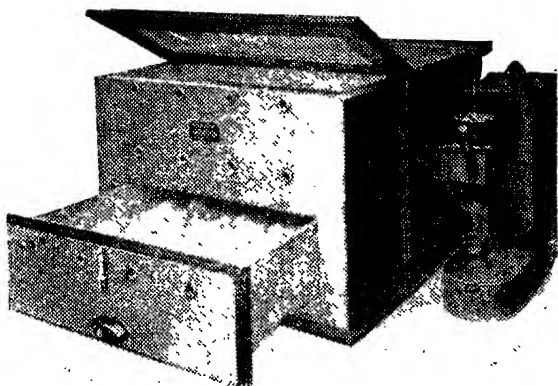


Fig. 95.—Tamlin's "Nonpareil" Incubator

thermometer; O, needle for communicating expansion of capsule S to lever G; P, milled-head screw; R, filling tube; S, capsule; T, paraffin lamp; V, chimney for discharge of surplus heat; W, chimney for discharge of products of combustion.

The action of the capsule is fully gone into in the chapter dealing with regulators, where also the Hearson gas attachments are described. It may be said that

## INCUBATORS AND CHICKEN REARERS

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the makers supply the incubator complete and ready for use, except for oil in the lamp, and water in the tank.

**Tamlin's "Nonpareil"** (W. Tamlin, Twickenham).—This is another high-grade machine, in design typical of the hydro class, and in workmanship everything that

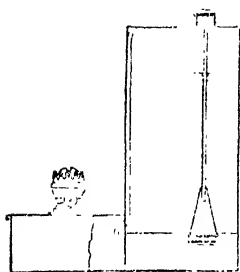


Fig. 96. Tamlin's Automatic Self-supplying Lamp

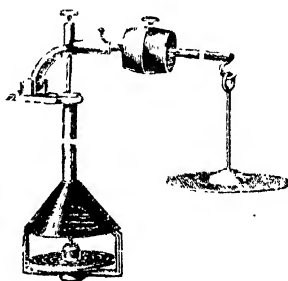


Fig. 97. Everall's Capsule Regulator

it need be. Its sizes (hen egg) are as follow :—30-egg, 60-egg, 100-egg, and 200-egg, besides which there is a 30-ostrich-egg. The maker claims great advantages from the strong construction of the wooden outer and inner cases, the former having brass fittings. The appearance of the 100-egg machine when fitted with drying box and a self- applying lamp, will be understood from Fig. 95. The shallow tank which, however, retains the same area or radiating surface underneath is a feature of all Tamlin

## VARIOUS INCUBATORS DESCRIBED

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machines; it is made of 8-lb. hard-rolled copper with four-fold seams. The smallness of the tank capacity is claimed to be a large factor in keeping down the consumption of fuel. The lamp is either of the ordinary kind, or it is of the automatic self-supplying kind shown in diagram by Fig. 96. The container holds enough oil to keep the lamp in use for three or four weeks, and by means of a special device the oil is maintained at the same level around the wick. The regulator is of the capsule type supported in a strong Brass stirrup, its speciality being the presence of a conical shield (*see* Fig. 97), made of a non-conducting material which prevents the capsule being influenced by heat radiation from the hot-water tank. The introduction of an insulator prevents any heat conducted by the stirrup from affecting the capsule.

**The "Peerless"** (H. M. Sheer Company, Quincy, Illinois, U.S.A.).—This has many points of novelty in its design, but it is no reflection upon its undoubted merits to say that it is not likely to be so popular with the British buyer as it is with the American public. It is made in two chief sizes, 100-egg and 200-egg, and the maker sends out the parts and fittings together with full instructions on putting them together. Fig. 98 is a longitudinal section through the essential parts of this machine. Air enters at A, passes between the double walls, and enters the egg chamber at B, where it is warmed by contact with the hot-water tank L. It escapes from the egg chamber

## INCUBATORS AND CHICKEN REARERS

at D, below the eggs, and from the machine at G, passing through flues E and F on the way. The tank is unlike that of any other commercial machine. As shown in Fig. 99; it has heat retaining and distributing bars underneath the tank, and there is a sheet metal deflector (not shown)

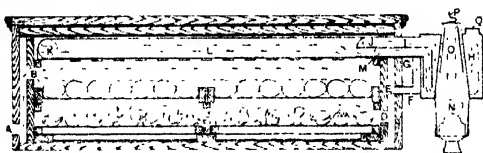


Fig. 98. - Section through "Peerless" Incubator

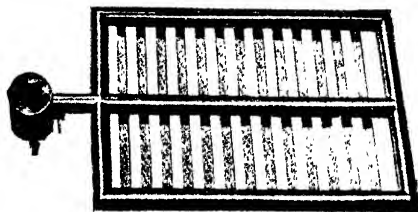


Fig. 99. - "Peerless" Tank

on top. The deflector radiates the heat, the makers say, and the bars absorb it, and, later, distribute it equally to all parts of the chamber. The tank capacity is, of course, comparatively small, and there should be a corresponding saving in fuel consumption. The water, heated in boiler H (see Fig. 98), passes through I to the tank cross-tube J, whence it travels in both directions around the outer tubes of the tank, entering the centre tube at K,

## VARIOUS INCUBATORS DESCRIBED

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returning to the boiler through m. The capsule regulator, of special construction as explained on pp. 95 to 97, ultimately controls the temperature by lifting or lowering the damper p. When p is lifted, all the heat from the lamp flame n passes direct through the central flue o, and escapes under the damper. When p is down, all the heat must pass between the inner flue o and the wall

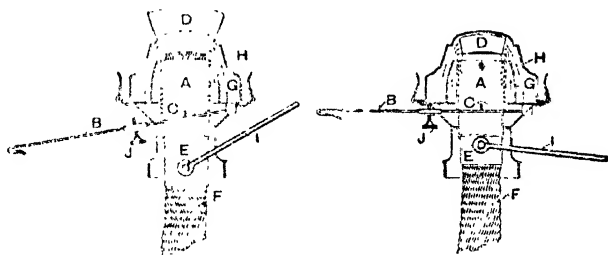


Fig. 100 and 101. - "Acme" Trip Burner

of the boiler n. Merely a slight lifting of the damper causes part of the heat to pass through o, and the other part between o and H.

The regulator controls the lamp flame as well as the damper, the size of the flame being reduced or increased according to requirements, thus conducing to economy. The "Acme" trip burner is shown by Figs. 100 and 101. It is made throughout of No. 24 gauge brass, pressed and not spun to shape. It has inner and outer domes, which, together with the controlling device, are instantly removable for cleaning. Referring now to Figs. 100 and



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101, the former showing the burner with full flame, and the latter with small flame, the wick *F* is held adjustable in a metal sleeve *E* connected by a stud to lever *I* to which is attached the light chain depending from the end of the damper rod (*see* Fig. 77, p. 96). Sleeve *A* is operated by trip lever *B* through lug *C*. *D* is the flame, *G* inner dome, and *H* outer dome. The maker supplies to order an automatic gas valve having a lever corresponding to lever *I* in Figs. 100 and 101, so that the supply of gas is reduced or increased as the damper rises or falls.

**The "Klondyke"** (Klondyke Incubator Company, Des Moines, Iowa, U.S.A.). There are many evidences of its American origin in this incubator. It is made in the following sizes (hen egg):-- 100- to 115-egg, 150- to 165-egg, 200- to 225-egg, and 250- to 290-egg, and an idea of the general construction can be gained from Fig. 102 which shows the incubator with part of the woodwork cut away to reveal the internal arrangement. The hot air from the lamp is conducted through a flue around which is the tubular water tank made of copper. The case is of cypress, lined with non-conducting paper, and is double-walled, with an air space between the walls. The sides, top, and bottom are constructed in the same way. To the egg chamber there is an outer wooden door and an inner glass one. The makers attach great importance to the lamp (the "Oakes Hydro Safety"), shown by Fig. 103; they say that smokiness and the growth in size of the

## VARIOUS INCUBATORS DESCRIBED

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flame are due to the upper end of the wick tube becoming hot enough to convert the oil along the sides of the wick into gas, which escapes at both ends of the wick tube, causing liability to explosion and an increase in the size of the flame. In the "Hydro Safety," the wick tube is

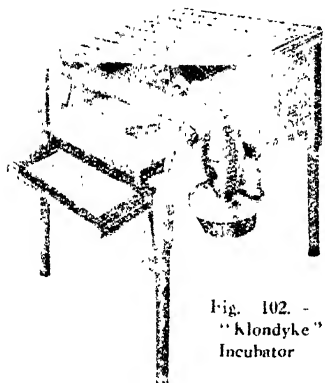


Fig. 102. -  
"Klondyke"  
Incubator

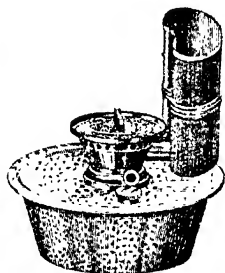


Fig. 103. - "Oakes' Hydro  
Safety" Lamp

water-jacketed just below its upper end; connection is made through brass tubes to the brass reservoir shown to the right in Fig. 103, so as to ensure a circulation of water around the wick tube.

Beneath the egg tray is the chicken nursery, which is at a lower temperature.

### **Combined Hydro and Hot-air Incubator**

**The Asbestic Hen** (R. Toope and Company, Stepney Square, High Street, Stepney, London, E.).--The speciality of this machine is that the sides, bottom, top, etc., which

## INCUBATORS AND CHICKEN REARERS

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in other incubators are made of wood, are in this case made of asbestos board, which does not crack, warp, rot, or harbour vermin, and in addition is a poor conductor of heat and non-combustible. There is an internal packing of much the same nature. The sizes (hen egg) are as follow :--24-egg, 36-egg, 60-egg, 100-egg, 200-egg, and 300-egg. The makers claim advantages from the special system of heating and ventilation, the former being accomplished by hot air and by radiation from a water tank, and the latter by moist heated air automatically supplied. The air entering from outside comes into contact with a hot flue and, in a warmed condition, passes into the egg chamber, down between the eggs to the floor level, thence to the open air up a ventilating shaft whose mouth is fitted with a slide to regulate the amount of air passing through the machine. During hatching time the slide is kept partly closed to retain the moisture necessary for the safe delivery of the chicks from the shells. The machine is heated, as already briefly indicated, by means of a hot-water tank through which passes a double flue. A moist air shaft is at the back of the machine and extends from underneath. The moist air from outside is admitted by this shaft, warmed by being distributed over the tank, and passed down through openings in the tank, and then reaches the eggs which it very slightly moistens. Thence the air passes between the eggs and escapes through the air shaft. The inventor is a firm believer in the theory that in

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natural incubation the necessary moisture is supplied by the respiratory organs of the hen's body—not from the ground.

An underneath nursery is a feature of the Asbestic Hen. The chicks on hatching pass from the egg tray to the nursery beneath, where the temperature is the more healthy one of 95° F. At slight extra expense, the machine can be fitted with an internal self-contained electric lamp, thus making it possible to illuminate the interior of the machine merely by pressing a button—a great advantage when requiring to read the thermometer or to observe the progress of hatching. The makers supply on request their "Saivtyme" turning tray with which the eggs can be quickly turned without touching them with the hands. Undoubtedly, the Asbestic Hen is an incubator with many novel but carefully thought-out features, and is well worthy of study.

### Hot-air Incubators

**The "Cyphers"** (Cyphers Incubator Co., Buffalo, New York, U.S.A., and 119 to 125 Finsbury Pavement, London, England).—This is perhaps the best known of all American incubators. It is made in the following sizes (hen egg):—70-egg, 144-egg, 244-egg, and 390-egg. The 244-egg machine, shown in Fig. 104, is typical of all the sizes, except that the smaller ones do not have nursery drawers which, in the illustration, are shown open.

The case is of white pine, the cavity between the outer and inner walls being packed with non-conducting material.

## INCUBATORS AND CHICKEN REARERS

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The method of heating is typical of many hot-air machines. The galvanised iron lamp contains a cylindrical brace to prevent buckling of the metal either top or bottom. For the purpose of ensuring a low, clear and steady flame during hot weather, the effective width of the top of the

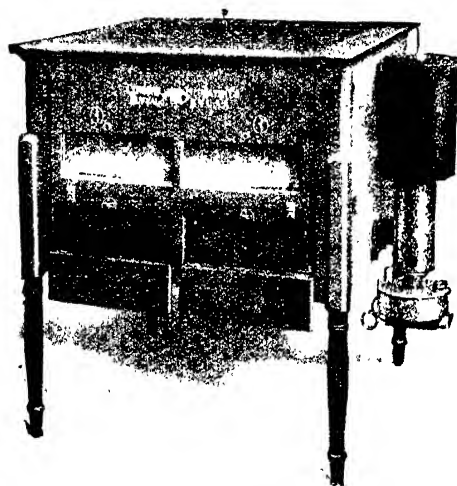


Fig. 104. The "Cypiers" Incubator

wick may be restricted by fitting a flame reducer, which merely slides on friction-tight.

The heater, directly over the lamp, is constructed according to the sectional view shown by Fig. 105, in which *l* is the main flue exhausting into *k*, through casting *r*. The fresh air is admitted through *h*, where it is warmed by contact with *i*; and it passes into the body of the

## VARIOUS INCUBATORS DESCRIBED

incubator through B, held in the flange casting C. The used air comes back via pipe D and casting E. A is the top cover casting with escape flue L, over which is the damper. An air-spaced asbestos jacket G,  $2\frac{1}{2}$  in. thick, covers the entire exterior of the heater. The warmed, fresh air on being admitted to the body of the incubator is diffused through porous diaphragms, which compose the

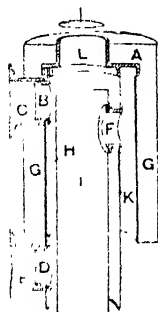


Fig. 105. "Cyphers"  
Heater .

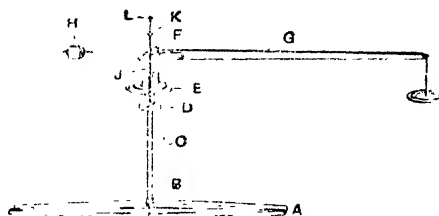


Fig. 106. "Cyphers" All-metal Regulator

upper and lower divisions of the egg chamber. The ventilation is quite automatic after the regulator has been adjusted. The second and third sizes of machine are provided with a drop-bottom; that is, the bottom panel consists of a frame enclosing a hinged bottom, which can be let down to any distance until it touches the floor, thus exposing the under-surface of the lower felt diaphragm, and facilitating ventilation in hot, dry weather.

The regulator or thermostat is of the all-metal type

## INCUBATORS AND CHICKEN REARERS

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(see Fig. 106), and is composed of three separate strips, two of zinc and one of steel, all having their long edges bent down at right angles, the zinc strips being notched at the centre. With differences of temperature, the zinc expands or contracts much more than the steel, and therefore the angle formed at the centre of the zinc bars is altered, thus imparting an up or down movement to a vertical connecting-rod, which movement is utilised in the customary manner to raise or lower a damper. In Fig. 106, which represents the thermostat and its connections diagrammatically, the letter references are as follows: A, thermostat; B, brass nipple for attachment of connecting tube C; D, centre guide casting, with base casting E; F, pivot casting to which is attached wooden arm G and counterpoise H; J, connecting-rod with adjusting nut K and lock-nut L.

**"Prairie State"** (Prairie State Incubator Co., Homestead City, Pa., U.S.A.; Finch and Fleming, Ltd., Flitwick, Beas).—This machine has a high reputation in Great Britain. The standard machine is now the "sand tray," the principal sizes (hen egg) being 100-egg, 150-egg, 240-egg, and 390-egg. The double walls are made of chestnut, poplar, or pine, the legs being of maple. The packing material is cotton batting and strawboard in alternate layers, the parts of the machine exposed to the greatest heat being insulated by mineral wool and asbestos. The makers guarantee the machine to be fireproof, and state that over a period of twenty years not one of their machines

## VARIOUS INCUBATORS DESCRIBED

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has caught fire. Much advantage is claimed from the fact that the heat distribution is on the "eddy-current" principle. The eddy-current, the makers say, had the effect in the imperfectly designed machine of causing non-uniform heating, hot spots occurring in the egg-chamber first in one place and then in another; but in the "sand tray" machine the eddy-current is employed as a vehicle for carrying the hot air to the cold parts of the machine. Ventilation is amply provided for, and does not influence the automatic heat distribution, the makers having such faith in the truth of this statement that in their largest machine they use a flat egg tray, which conduces to quickness and ease of turning. The heater is, as usual, on the outside of the machine, and in its construction it is lapped, seamed, riveted, and soldered. Any soot deposits, should they occur, can be readily removed. It is insulated with an asbestos jacket covered with a neat hood, its exhaust being a small round pipe so arranged that the lamp fumes can be taken directly into the outer air.

A current of warm pure air enters the machine from the heater, and is forced continuously through the egg chamber, but from this point onwards the ventilation is on a different principle from what is customary. The heating current goes down part of the way in the egg chamber, and passes through apertures in the walls above the eggs; consequently there is a direct current only in the upper part of the egg chamber, the actual ventilation of the eggs being



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caused by molecular diffusion. The air, having passed through the apertures in the walls, flows downward into a space under the nursery, where it is released, thoroughly warming the bottom of the machine and then passing away through holes to the outside air. The eggs do not receive any bottom heat, the warm air current merely warming the nursery to a temperature of from 85° to 90° F., depending upon the temperature of the room. The entire bottom of the machine is occupied with a galvanised iron pan containing wet sand; this moisture is being constantly given off underneath the eggs, which, according to the makers, is a very close approach to the natural conditions found with the hen. At the end of the incubator is a suction tube communicating with the bottom of the chicken nursery and opening into the outside air; by its means, whenever desired, a current of air can be sent through the eggs and nursery with the object of carrying off moisture and hardening the chicks during the latter part of the exclusion period. The regulator, patented as recently as 1907, comprises a special design of steel-zinc thermostat. The attachment to the regulator rod is at the extreme end of the device, and not, as in the majority of metal thermostats, at the middle.

Below the egg trays is the nursery, into which the chicks fall through an aperture formed by removing a loose slip at the front. The bottom of the nursery is covered with a canvas mat tacked to a light removable

## VARIOUS INCUBATORS DESCRIBED

frame, the back part of which is a wide board ; by means of this frame the chicks can be withdrawn.

• **The "Gloucester"** (The Gloucester Incubator Company, Gloucester).—This is a well-made machine of British manufacture, although in many respects reminiscent of American design. It is made in the following sizes (hen egg) : 40-egg, 66-egg, 100-egg, 150 egg, 250-egg, and 390 egg. It has a well-made case, the outer walls being

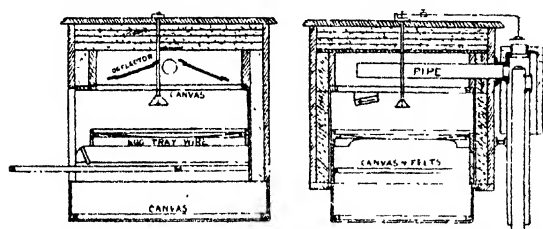


Fig. 107 and 108. Sections through "Gloucester" Incubator

made of kiln-dried and tongued very narrow boards, mortised and tenoned and screwed and glued together ; the theory, based on a generally known fact, is that the narrower the boards the less is the trouble from shrinkage. In the cavity between the double walls is packed laminated vegetable cotton ; and in places, notably over the heating pipes, the insulation takes the form of layers of cotton-wool between strawboards, the whole being greatly compressed. For heating the incubator, the lamp is supported at the side of the machine, as in a hydro incubator, insulated therefrom by means of asbestos lagging. The

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lamp, by means of a toggle lever device, can be either fixed or removed with the utmost ease ; the bracket forms a support upon which the lamp can remain while trimming and filling. The makers have adopted a special form of burner and a self-filling lamp ; in the latter the oil is kept automatically at a uniform level, it being possible to remove the reservoir to get at the burner if desired. The special burner comprises a mechanical wick trimmer, by means of which the wick can be trimmed in an instant without moving the lamp.

The heater itself is of the type illustrated by Fig. 105, p. 133.

Figs. 107 and 108 show two sections through the incubator. The pipe introducing the warm air will be noticed. The deflector or defle directs the air over a double porous diaphragm of canvas, and into the egg-chamber in which the eggs lie upon a wire cloth tray sloping towards the centre. The air passes down through the machine, and ultimately escapes at the bottom. By the use of removable felts below the eggs, the amount of air passing through the machine is easily controlled. The lower felt is partly exposed to the outside air, this being a factor in maintaining correct humidity.

Between the front of the egg tray and the door by which the chicks find access to the nursery beneath is a space of about 3 in., occupied until, say, the first or second testing with a movable wooden slip upon which eggs may

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be placed. When "pipping" starts, the slip is removed. The chicks on hatching are attracted by the light, and in moving towards it they drop down upon a sliding platform. There is no need to take out the drawer and transfer the chicks from egg-chamber to nursery. The platform is slowly withdrawn, so causing the chicks to drop into a drawer having a stretched canvas bottom. The use of this arrangement obviates the temptation to open the door during a hatch, and consequently cooling the chamber.

**The "New Buffalo"** (Buffalo Incubator Company, Buffalo, New York, U.S.A.).—This incubator is the production of Charles A. Cyphers, and follows in very many respects the well-known Cyphers models. The sizes are :— 50- to 60-egg, 110- to 120-egg, 220- to 240-egg, and 340- to 360-egg. The case is made of galvanised iron lined with fibre-board ; the cavity between the double walls is filled with non-conducting material. The front is of hard wood, with both wooden door and glass door to egg-chamber. The heater is on the Cyphers model, its casing being of asbestos enclosed in a galvanised-iron jacket. The heating and ventilating system is on the Cyphers style. The regulator is of metal. Wire-cloth egg-trays are employed.



## CHAPTER IX

### Chicken Rearers or Foster-mothers

FOR chickens that have been hatched by artificial means a substitute for the natural mother is a prime necessity during the first few weeks of their lives. If strong, hardy birds are to be ensured, coddling must be avoided ; yet, until the chicks have their feathers, they must be provided with a well-warmed retreat to which they can have access at will. Free ventilation must be provided, but draughts must be guarded against ; there must be no corners into which the chicks may huddle ; and the heat source should, if possible, be central.

All the leading incubator manufacturers have their own special designs of rearers, which, in the majority of cases, can be depended upon. The purpose of this chapter is not to describe the many commercial rearers, but to give plain instructions on making some rearers which have answered excellently in practice.

**160-chick Rearer with Run.**—The foster-mother shown in Fig. 109 is heated by a tank similar to an incubator tank, the lamp being in a separate compartment. The run is made separate from the hot chamber, the foster-mother proper, and is secured to it by a couple of

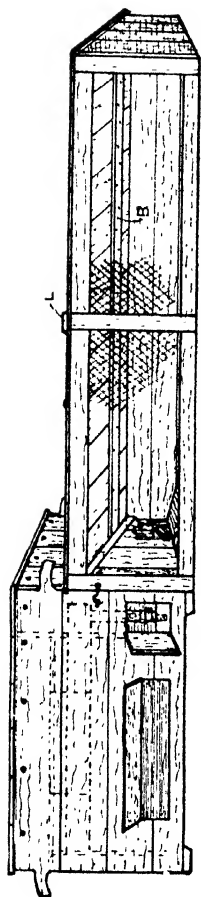


Fig. 109. - Front View of Rearer

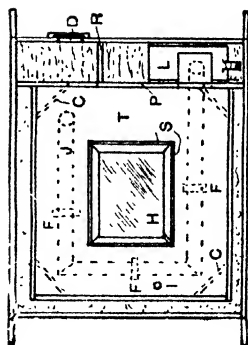


Fig. 110. - Horizontal Section through Rearer.

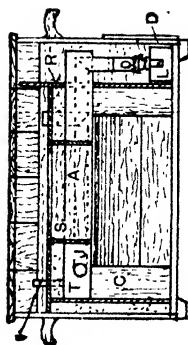


Fig. 111. - Vertical Section through Rearer

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hooks, with staples to match. By unhooking, the chamber and chicks may be moved by the handles shown in Figs. 109 to 111, and may be so carried indoors nightly in very cold or stormy weather, if deemed advisable. Fig. 112 shows an end view.

The length over all is 10 ft., of which the run measures 6 ft. 10 in. and the hot chamber 3 ft. 2 in. The extreme width is 2 ft. 10 in.

The tank *T* is of zinc throughout, except the flues, which are of 8-lb. copper, and is 2 ft. 6 in. wide by 2 ft. 4 in. long, plus the flue extension into the lamp chamber, which is 5 in. long by 4½ in. wide. The tank is clearly shown in Figs. 110 and 111. It is 3¼ in. deep, and has flues *J* of 2-in. diameter extending round three of its sides (see Fig. 110). These flues are secured ½ in. from the bottom plate with three small feet formed by soldering strips of zinc ¾ in. wide to the flues, bending them down to the form shown in Fig. 113, then soldering them in place on the bottom as indicated at *r* (Fig. 110). A filling tube *I*, ¾ in. in diameter, is provided.

An aperture *A* through the tank measures 1 ft. 4 in. by 1 ft. 1 in. It is lined with strips of wood *s* (Fig. 110) 5 in. wide and ½ in. thick. To these strips is fitted and hinged a glazed door *H*, which gives a clear view of the interior, and allows access for cleaning out, etc. The corner pieces *C* support the tank and are 9 in. high by 6 in. wide, the tank being 9 in. from the chamber floor.

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The inner walls are made to fit the tank body, one end being long enough to extend across to the outer walls, thus forming the partition wall *p* of the lamp chamber. The outside walls measure 3 ft. 2 in. long by 2 ft. 10 in. wide over all, and are 2 ft. high at the front, sloping to 1 ft. 8 in. at the back, and are  $\frac{7}{8}$  in. or 1 in. thick. A hinged top covers all. A door for cleaning purposes, 1 ft. 8 in. long by  $4\frac{1}{2}$  in. wide, is provided, and another 5 in. by 6 in., gives access to the lamp.

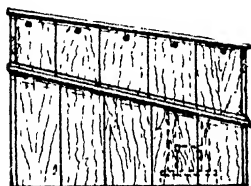


Fig. 112. — End View of Rearer



Fig. 113. -- Section through Rearer Flue, showing Feet

The lamp chamber is  $5\frac{1}{2}$  in. wide, and has a cross partition *r* to prevent the chicks reaching the lamp *L* while passing in and out of the doorway *D*. The lamp is 11 in. long by  $2\frac{1}{2}$  in. deep, and of a width to fit its compartment loosely. It has a 1-in. burner and a loose metal chimney having a turned-in lapped or riveted joint and a mica-covered peep-hole. The tank and side spaces are packed with sawdust to the level of the strips *s*, and are covered in with  $\frac{1}{2}$ -in. pine.

A doorway *D* to the hot chamber,  $4\frac{1}{2}$  in. wide by 5 in. high has a door sliding in guides, which can be lowered



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at night. A small gangway about 7 in. wide slopes from the door level to the run floor.

The run is 1 ft. 8 in. high at the front, sloping to 1 ft. at the back (*see* Fig. 112). The roof is hinged in two lengths, the joint being covered by a strip L (Fig. 109), 3 in. by  $\frac{1}{2}$  in., secured to one-half, so as to lap over. Two 4-in. battens (one, B, only being visible inside the roof at Fig. 109) run the full length of each roof section, and are well secured with nails driven through and clinched. The front frame is in one piece, and is covered with wire netting of  $\frac{1}{2}$ -in. mesh.

An ordinary thermometer should be hung in the chick chamber, and the temperature should be for the first week 90°, the second week 80°, and the third week 70°; but if the weather is warm 5° or 10° lower will be ample for the first fortnight. These temperatures are better for outdoor rearing. The foster-mother should face south in fine weather, but be turned with back to the rain:

**60-chick rearer.**—Another style of rearer is shown in Figs. 114 to 116. The woodwork is composed of matchboards and scantling. To accommodate sixty chicks the rearer may be 7 ft. long, 2 ft. wide, and 2 ft. high at the back, and 2 ft. 6 in. high in the front. The matchboards are 6 in. by  $\frac{3}{8}$  in. all through, and the scantling is 4 in. by 1 in. The back will require fourteen matchboards, 2 ft. by 6 in. by  $\frac{3}{8}$  in. The lengths of scantling are: Two pieces for the back legs, 2 ft. by 4 in. by 1 in.; two pieces

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for the front legs, 2 ft. 6 in. by 4 in. by 1 in.; two pieces for each end, 2 ft. by 4 in. by 1 in.; two pieces to form back and front rails at the bottom, 7 ft. by 4 in. by 1 in.; and two pieces to form the top rail, from the ends of which the handles are formed. The top rails must be 7 ft. 6 in. by 4 in. by 1 in.; therefore 42-ft. run will be required. The two ends of the rearer are alike (*see* Fig. 116). The sleeping place is 2 ft. square. A partition (Fig. 117) is

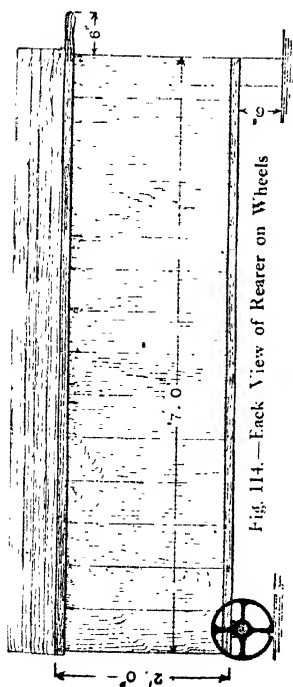


Fig. 114.—Back View of Rearer on Wheels

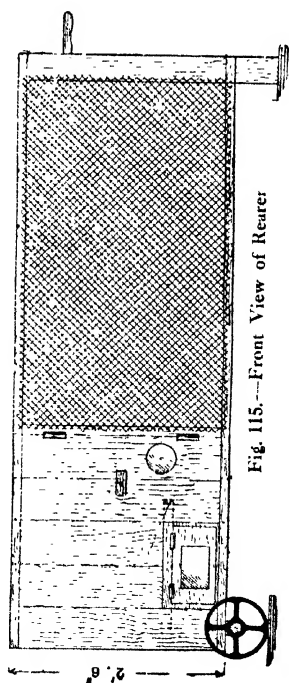


Fig. 115.—Front View of Rearer

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fixed 2 ft. from one end, and another partition 6 in. from it, thus leaving a space of 6 in. in which the lamp slides, but there must be a hole cut in the two pieces for the chicks to pass through from the run to the sleeping place behind the end of the lamp.

The rearer is mounted on two 9-in. cast-iron trolly wheels, which are fixed at the opposite end to the handles ; thus the rearer is easily wheeled to fresh ground. These

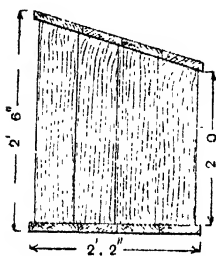


Fig. 116. - End View of Rearer

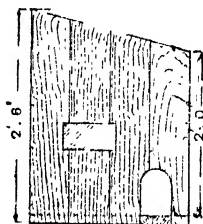


Fig. 117. - Partition for Rearer

wheels run on a piece of gas barrel about 2 ft. 6 in. long, which is fixed by means of two plate staples 1 in. wide, which are crewed to the scuffling. The ends are fixed to the back and front by 4-in. cut nails driven in on the skew. To fix the floor, two 2-in. by 1-in. fillets are nailed the full length of the rearer, and the matchboard is nailed down to it.

The top is made in two parts ; one covers the sleeping place and lamp shelter, and the other covers the run. The top should be 7 ft. 6 in. long and 3 ft. wide, thus lapping all round to run the rain well off.

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The tank should measure 1 ft. 10 in. square by 3 in. deep, and must be placed with its bottom 9 in. above the floor. Its central hole is 1 ft. square, so that the birds can be got at from the top and the rearer itself cleaned out. Stout sheet zinc, say No. 11 or No. 12 s.w.g., answers the purpose, but copper is to be preferred. It is cut on the lines of Fig. 118, and bent at right angles, thus forming the bottom of the tank. The top of the tank is cut in the same way in the centre. Thus two sides are formed

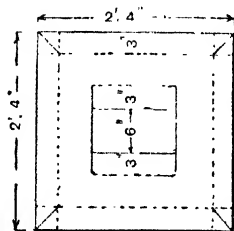


Fig. 118. —Pattern for Rearer Tank

of the centre hole out of the top, and two sides out of the bottom. This tank must be well soldered together.

The flow and return copper pipes,  $\frac{1}{2}$  in. in diameter, are next fixed to the boiler and tank, as shown in Fig. 119, and a small tank is fixed on top of the large one for filling, and must always be kept full so that the jacket boiler and large tank are also full. An air pipe is fixed beside the small tank, and stands 1 in. above it. The filling pipe dips 1 in. into the large tank, but the air pipe must be fixed flush on the top of this tank to allow the air to get

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away and prevent the water getting air-locked. The small supply tank is 3 in. by 2 in., and both pipes are  $\frac{1}{2}$  in. in diameter. The return pipe must have a dip in it as at A (Fig. 119), and this will prevent the hot water flowing up it. Fig. 120 shows the inside portion of the boiler, and the two pipes B must be soldered in place before sliding this part into the outer jacket. About  $\frac{1}{2}$  in. space between the inner and outer cases is sufficient. The two ventilating tubes are  $\frac{3}{4}$  in. long by  $\frac{1}{2}$  in. in diameter.

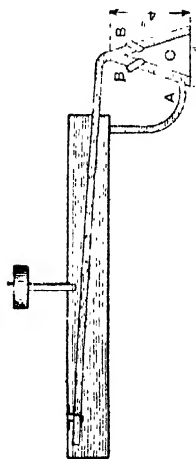


Fig. 119.—Rearer Boiler and Tank

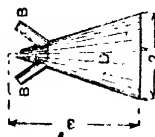


Fig. 120.—Inner Part  
of Rearer Boiler

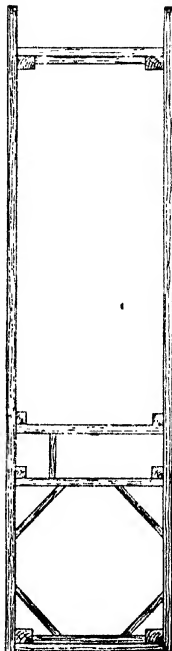


Fig. 121.—Plan of Rearer Frame

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The tank and boiler being ready, next fix in each corner of the sleeping place a length of wood 9 in. by 6 in. wide. These pieces (*see* the plan, Fig. 121) shut off the corners, and so prevent the birds getting crushed to death in the corners, which is so often the case when square sleeping places are used. Thus a resting-place is made for the tank, and a 1-in. space is left all round the tank to be filled with sawdust or silicate of cotton. A 1-ft.

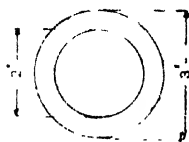


Fig. 122.—Copper Ring for Rearer Boiler

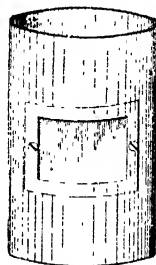


Fig. 123. Burner Chimney

square frame 3 in. deep is now fitted tightly into the square hole in the middle of the tank and allowed to stand up 1 in. above the surface. Next fill in all over the tank with sawdust to keep the heat in, and nail a  $\frac{1}{2}$ -in. fillet all round the inside of this frame, say 1 in. down, on which a wooden lid rests. This lid can be easily removed for cleaning-out purposes or for attending to the chicks from the top of the rearer.

A copper ring (Fig. 122) is cut and passed over the top of the part shown by Fig. 120 and soldered round the

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bottom of it. The inner portion of the boiler *b* (Fig. 120) is now placed inside the outer jacket, and the ring soldered to the bottom edge of the outer jacket, thus forming the bottom of the jacket. The partition for the sleeping place should have a glass in it just under the boiler, so that the lamp lights the sleeping place; a hole should also be made in the farther corner at the back.

With regard to the distance of the burner from the end of the lamp, the collar of the burner should be soldered on about 1 in. from the end of the petroleum container; but it will be better to get the cone boiler in place first, and then to put the burner underneath the middle of the cone. The best burner to use is a 1-in. Queen Anne.

The chimney may be constructed of thin tinplate, the diameter being the same as that of the burner gallery; the height is regulated by the distance between the bottom of the boiler and the burner, usually 4 in. An oblong hole is cut in the tin, about 2 in. long by  $1\frac{1}{2}$  in. deep. A piece of mica is placed over this hole (*see* Fig. 123). A brass frame fixed to the chimney by means of a fender screw and nut at each end keeps the mica in position; thus it is possible to see the flame without opening the door.

The height of the chimney will depend on the depth of the lamp. If the lamp is 1 in. deep and the burner 1 in., then 3 in. will be left between the boiler bottom and the rearer floor; in that case the chimney would be  $2\frac{1}{2}$  in. high, thus allowing  $\frac{1}{2}$  in. clear between the top of

## CHICKEN REARERS OR FOSTER-MOTHERS

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the chimney and the bottom of the boiler. The lamp may be 1 ft. 6 in. long, 4 in. wide, and 1 in. deep.

- **A cold brooder**, into which the chicks may be turned when fledged, and when no longer in need of artificial heat, is shown in Fig. 124. This period cannot be arbitrarily fixed, as much will depend upon the state of the weather, but from three to six weeks old may be taken as the

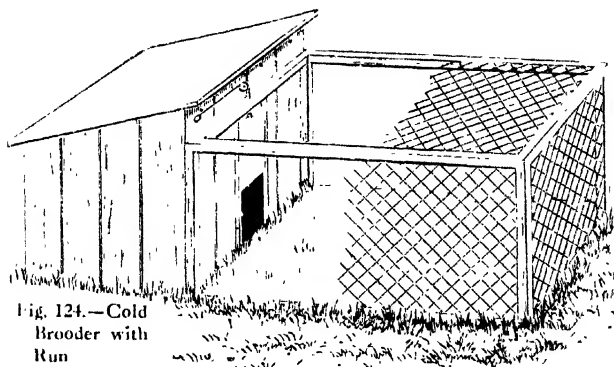


Fig. 124.—Cold  
Brooder with  
Run

average age at which artificial heat may be dispensed with. This brooder may be 2 ft. square, the same in height at back, and 6 in. higher in front; and the run 4 ft. long and 14 in. high. The house portion can be constructed of matchboarding with the whole of the back hinged with cross garnets to open, and for the framing of the run 2-in. by 1-in. slate batten will be just the thing. If the top of this is hinged as in Fig. 124, it will be found a convenience for inserting food and water.



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